WORLD PETROLEUM

RUSSELL PALMER
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VOLUME 10 **MARCH . 1939** **NUMBER 3**

WORLD PETROLEUM: Incorporating Petroleum Equipment Exporter

CORRESPONDENCE

ADDRESS all correspondence regarding subscription and business matters to the Home Office; 95 River Street, Hoboken, N. J.

Editorial and Advertising offices; 56 West 45th Street, New York, N. Y. London office; 3 Savoy Place, Victoria Embankment, W.C.2.
Los Angeles office; 412 West 6th Street

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ANNUAL subscription to WORLD PETROLEUM is offered at the flat rate of five dollars (U. S.) postpaid to any country in the International Postal Union.

For the convenience of subscribers the publisher will accept payment in any of the following currencies at the fixed rate shown below:

Argentina	16 paper dollars
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Colombia	5.55 pesos
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Remittances or drafts should be drawn to the order of the Publisher, WORLD PETROLEUM, payable in New York and London.

Subscriber's name and address should be in Roman capitals on the subscription order.

Official position of subscriber is requested.

Advance notice, if possible, of a change of subscriber's address should be given.

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SINGLE copies of WORLD PETROLEUM are obtainable every month, within the delay imposed by the international mail service, at any of the following agencies:

CABIMAS, VENEZUELA—The German Store
BERLIN, 25, W. GERMANY—Verlag Chemie G.m.b.H. Corneliusstrasse 3.
MARACAIBO, VENEZUELA—High Life Tailors
THE HAGUE—Martinus Nijhoff, Lange Voorhout 9
LONDON—World Petroleum, 3 Savoy Pl., Victoria Embankment, W.C.2, telephone: TEMple Bar 1735
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NEW YORK—Telephone Hoboken 3-2180 for list of 20 newsstands carrying copies.
PARIS—Librarie Brentano, 37 Avenue de l'Opera
PORT OF SPAIN, TRINIDAD—Davidson & Todd, Ltd., 8 Frederick St.
LOS ANGELES—412 West 6th St., telephone: Mutual 1391

The price of monthly copies is 2 shillings in countries of the British Commonwealth and the equivalent of 50 cents (U. S.) elsewhere.

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El Presidente de la República de Colombia

COLOMBIAN PETROLEUM POLICY

By Dr. Eduardo Santos, *President of the Republic*

(Exclusive statement to World Petroleum—Bogota, 20th August 1938)

THE policy of the Colombian Government with respect to the development of the hydrocarbon and in general with the subsoil resources will be none other than to combine the dictates of justice and consideration of the legitimate rights with the firm defense of the Colombian interests.

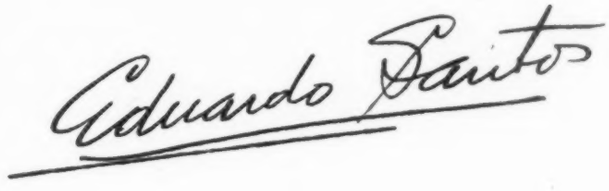
Certain thinkers viewed the countries of the New World as a semi-colonial type, referring specially to the exploitation of the natural resources, holding such views from conditions of former times, now definitely vanished. There shall not exist again among us that type of semi-protectorate under which the might of capital or of outside powers, places the country in a subordinate position, more or less precarious. Foreign capital will be welcome among us but only on a basis of strict obedience to our laws and authorities and faithful respect to our national sovereignty.

The intervention of the State in the progress of the economy will not be, nor can it be of such a dominating nature as to constitute a hindrance that may render difficult or menace all initiative; but one of cordial cooperation, defense of the permanent interests of the commonwealth carried out with a criterion of sympathy and respect.

EL criterio del Gobierno de Colombia, en lo que se refiere al aprovechamiento de los hidrocarburos y en general a las riquezas del subsuelo, no será otro que el de combinar los dictados de la justicia y el respeto a los derechos legítimos con la defensa incontrastable de los intereses colombianos.

De países de tipo semi-colonial, en cuanto a la explotación de las riquezas nacionales se refiere, calificaban algunos pensadores a los del Nuevo Mundo, basándose para ello en situaciones de otras épocas, desaparecidas definitivamente. No ha de volver a existir entre nosotros ese tipo de semi-protectorado en que la fuerza de capitales o poderes extraños colocaba al país en una situación subordinada, más o menos precaria. El capital extranjero será bienvenido entre nosotros, pero sobre la base del estricto obedecimiento a las leyes y autoridades, y el respeto constante a la soberanía nacional.

La intervención del Estado en la marcha de la Economía no será, ni puede ser, tutela imperiosa, ni menos traba que todo lo dificulte o amenace, que coarte toda iniciativa, sino cooperación cordial, defensa de los intereses permanentes de la colectividad, llevada a cabo con un criterio de simpatía y de respeto.



EQUITABLE COLOMBIAN OIL LAWS

Drafted by Technical and Legal Experts

By Dr. Jorge Gartner, Minister of National Economy

In August, 1938, Dr. Jorge Gartner, Minister of National Economy, Granted an Exclusive Interview in Bogota to World Petroleum's Managing Editor—He Reviewed the Oil Laws and Touched on the Desirability of Further Development of the Petroleum Industry in Colombia—The Substance of This Interview as Approved by Dr. Gartner Is Reproduced Herewith.

Left: Dr. Jorge Gartner, Minister of Economy in the Cabinet of President Santos: The Colombian Petroleum Department comes under the direction of this Ministry, has recently been reorganized and is now intensely active in handling applications for concessions, drilling permits. Opposite: a monument on the road from Bogota to Cucuta commemorating the Battle of the Bridge of Boyaca which occurred on August 7, 1819, sealing the independence of Colombia.

EVERYTHING concerned with petroleum concessions in the country is established principally in Law 37 of 1931, which was complemented by Law 160 of 1936 wherein various points were clarified and amplified and where there was defined in a special manner what constitutes private petroleum property.

Considering that these laws were fully discussed with the participation of jurists and technical experts, both national and foreign, specialists in all the aspects which the subject offers; moreover if it is considered that before adopting said statute the legislation of all the petroleum producing countries was carefully studied with the expressed purpose of adopting measures favorable to the development of this industry, one must necessarily admit that the fundamental petroleum law in Colombia embodies most serious thought and offers guarantees seldom enjoyed by entrepreneurs.

Copy of these laws, all related legislation and regulations will be forwarded to anyone interested upon request to the Petroleum Department of the Ministry of National Economy.

The principal features of this legislation are as follows:

Any natural or juridical person may acquire in an exploration and exploitation petroleum contract up to 50,000 hectares, other than in zones of the eastern plains where the area may be as much as 200,000 hectares. Transfers of concessions are permitted to the same person up to 50,000 hectares in the first zone but such transfers may not be made to foreign governments.

The period of exploitation is thirty years which may be extended ten years. For exploration three years are allowed and may be extended six years. The period of exploitation commences upon expiration of the exploration term.

The contractor is required to pay the Government from 10 centavos to 2.00 pesos per hectare per year during the exploration, and the exploitation requires a payment from 11 percent to 2 percent of the gross production, according to whether the distance from the maritime port of shipment is between zero and 900 or more kilometers.

Processing of gases pays a royalty of 1/30th of the amount of natural gasoline extracted, or a payment of 5 centavos per 10,000 cu. ft. when sold.

Every contract for exploration and exploitation of petroleum with the Government grants the right to construct the necessary pipelines for the concession. There are no taxes nor special royalties on

EQUIDAD DE LAS LEYES PETROLERAS COLOMBIANAS

Proyectadas por Juristas y Técnicos Expertos

Por el Dr. Jorge Gartner, Ministro de la Economio Nacional

En Agosto de 1938, el Dr. Jorge Gartner, Ministro de la Economía Nacional, Concedió una Entrevista Exclusiva en Bogotá al Redactor en Jefe de World Petroleum — El Dr. Gartner se Refirió a las Leyes Petroleras y Mencionó la Conveniencia de Continuar Desarrollando la Industria del Petróleo en Colombia — A continuación Reproducimos un Resúmen de Dicha Entrevista Según fué Aprobada por el Dr. Gartner.

TODO lo concerniente a concesiones petrolíferas en el país está determinado de manera principal en la ley 37 de 1931, que fué complementada por la ley 160 de 1936, en la cual se aclararon y ampliaron algunos puntos y se definió de manera especial lo que constituye la propiedad privada del petróleo.

Si se tiene en cuenta que estas leyes fueron ampliamente discutidas con intervención de juristas y técnicos nacionales y extranjeros especializados en todos los aspectos que la materia ofrece; y si se considera además que antes de adoptar dicho estatuto se estudiaron cuidadosamente las legislaciones de todos los países productores de petróleo, con el ánimo de dictar medidas favorables al desarrollo de esta industria, es necesario admitir que la ley fundamental de petróleos en Colombia está revestida de la mayor seriedad y brinda garantías poco comunes a los empresarios.

Estas leyes y todas las disposiciones con ellas relacionadas se remitirán a quien tenga interés en conocerlas y las solicite al Departamento de Petróleos del Ministerio de la Economía Nacional.

Las principales características de esta legislación son las siguientes:

Toda persona natural o jurídica puede adquirir en contrato de exploración y explotación de petróleo hasta por 50.000 hectáreas en zonas distintas de las llanuras orientales, en donde la extensión puede ser hasta de 200.000 hectáreas. Los traspasos de concesiones sólo se permiten a una misma persona hasta por 50.000 hectáreas en la primera zona; pero no se pueden hacer a Estados extranjeros tales traspasos.

El plazo de la explotación será de 30 años prorrogables por 10 años más. Para la exploración se dan 3 años prorrogables por 6 más. El plazo de explotación se cuenta desde cuando termine el de exploración.

El contratista pagará al Gobierno, de $0.10 a $2.00 por cada hectárea durante la exploración, y en la explotación pagará del 11% al 2% del producto bruto en el puerto de embarque, según que la distancia al puerto marítimo de embarque sea entre cero a novecientos o más kilómetros.

Los gases pagarán una trigésima parte de la gasolina natural obtenida o cinco centavos ($0.05) por cada 10.000 pies cúbicos de gas vendido.

Todo contrato de exploración y explotación de petróleos con el Gobierno da derecho a construír los oleoductos necesarios para la concesión. No existen impuestos ni

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the service given by these pipelines. Contracts may be made for pipelines by non-exploiting companies, in which case a tax is payable to the Government of 2½ percent of the value obtained by multiplying the number of barrels transported by the prevailing tariff for the pipeline.

Petroleum contracts grant the right of eminent domain over private lands which are necessary for the benefit of the concession.

Concessionaires have the right of exercising eminent domain which is indispensable for carrying out the work of the concession. In each and every case the proprietor must be paid a just indemnification.

The establishment of refineries is free but it is necessary to obtain a permit from the Government to construct these within a radius of 20 kilometers of certain maritime ports.

The petroleum industry is exempt from departmental or municipal taxes also from the national river tax. Crude petroleum is exempt also from an export tax and from any other tax of special character.

Among these taxes the principal one is levied on income which taxes net profits that the petroleum companies may obtain, the same as is applicable to any other industrial enterprise, in a progressive manner as indicated in Law 78 of 1935.

Concessionaires must comply at all times with the social laws in force, insamuch as these are considered for the public interest.

Within the country there are private petroleum properties which the State recognizes and respects without lessening their rights. Private owners may negotiate freely the sale or exploitation of such petroleum. The State limits itself to the examination of the titles and to collect, once petroleum is exploited, a tax, ranging from 7 percent to ½ percent of the gross production according to whether the distance from the maritime port of shipment is between zero and 900 or more kilometers.

There are established in Colombia various important petroleum companies such as the Tropical Oil Company, the Colombian Petroleum Company, the South American Gulf Oil Company, The Texas Petroleum Company, the Richmond Petroleum Company, the Shell Petroleum Company, El Condor Oil Company, Socony-Vacuum Oil Company, Andian National Corp., Ltd.

To date only 1,750,000 hectares have been granted and from information in recent publications it is known that there are companies which have given orders to their representatives to obtain the greatest number of concessions in Colombia.

At present the Tropical Oil Company obtains an annual production of 20,000,000 bbl. of petroleum and the concession of the Colombian Petroleum Company has a gauged initial production of more than 10,000,000 bbl. of oil per year with less than 30 wells and with the circumstance that there are wells with potential flush production of 8,000 bbl. daily.

Airview of Barrancabermeja, Colombia, center of

There is a vast area of prospective oil land in the country which awaits exploration and investigation to ascertain its potentialities and it is therefore timely to request concessions.

Once a contract is made it cannot be altered but by mutual agreement. The Government of Colombia maintains an uninterrupted tradition in the fulfillment of its contracts and has in the organization of its Courts an absolute independence from the Executive Power and thus the Courts of Justice may pronounce judgment against the Nation to fulfill or indemnify whatever damages that may be suffered. The expressed will of the Government is to fulfill faithfully its obligations without search for subterfuges which may place in the least doubt its seriousness and good faith. Likewise it demands an honorable and clean fulfillment from the persons with which it enters into a contract.

of Bogotá of Colombia © Scadta

regalías especiales por el servicio de estos oleoductos. Se pueden celebrar contratos sobre oleoductos cuando se trate de compañías no explotadoras, caso en el cual se debe pagar al Gobierno un impuesto del 2½% del valor resultante de multiplicar el número de barriles transportados por la tarifa vigente para cada oleoducto.

Los contratos sobre petróleos dan derecho a la expropiación de las tierras de propiedad privada que sean necesarias para el beneficio de la concesión. Gozan los contratistas de las servidumbres que sean indispensables para la efectividad de los trabajos de la concesión. En uno y otro caso se debe pagar al propietario justa indemnización.

El establecimiento de refinerías es libre, pero es necesario permiso del Gobierno para establecerlas en un radio de 20 kilómetros alrededor de ciertos puertos marítimos.

Toda la industria del petróleo está exenta de impuestos departamentales o municipales y del nacional fluvial. El petróleo crudo está exento, además, del impuesto de exportación y de cualquier otro impuesto de carácter especial, pero los impuestos de índole general distintos del de exportación sí deben pagarse.

Entre estos impuestos el principal es el de la renta que grava las utilidades líquidas que obtengan las compañías de petróleos, lo mismo que cualquier otra empresa industrial en forma progresiva de la manera indicada en la ley 78 de 1935.

Los contratistas deben cumplir las leyes sociales vigentes en cada momento de la concesión, pues estas leyes se consideran de interés público para los efectos de su aplicación.

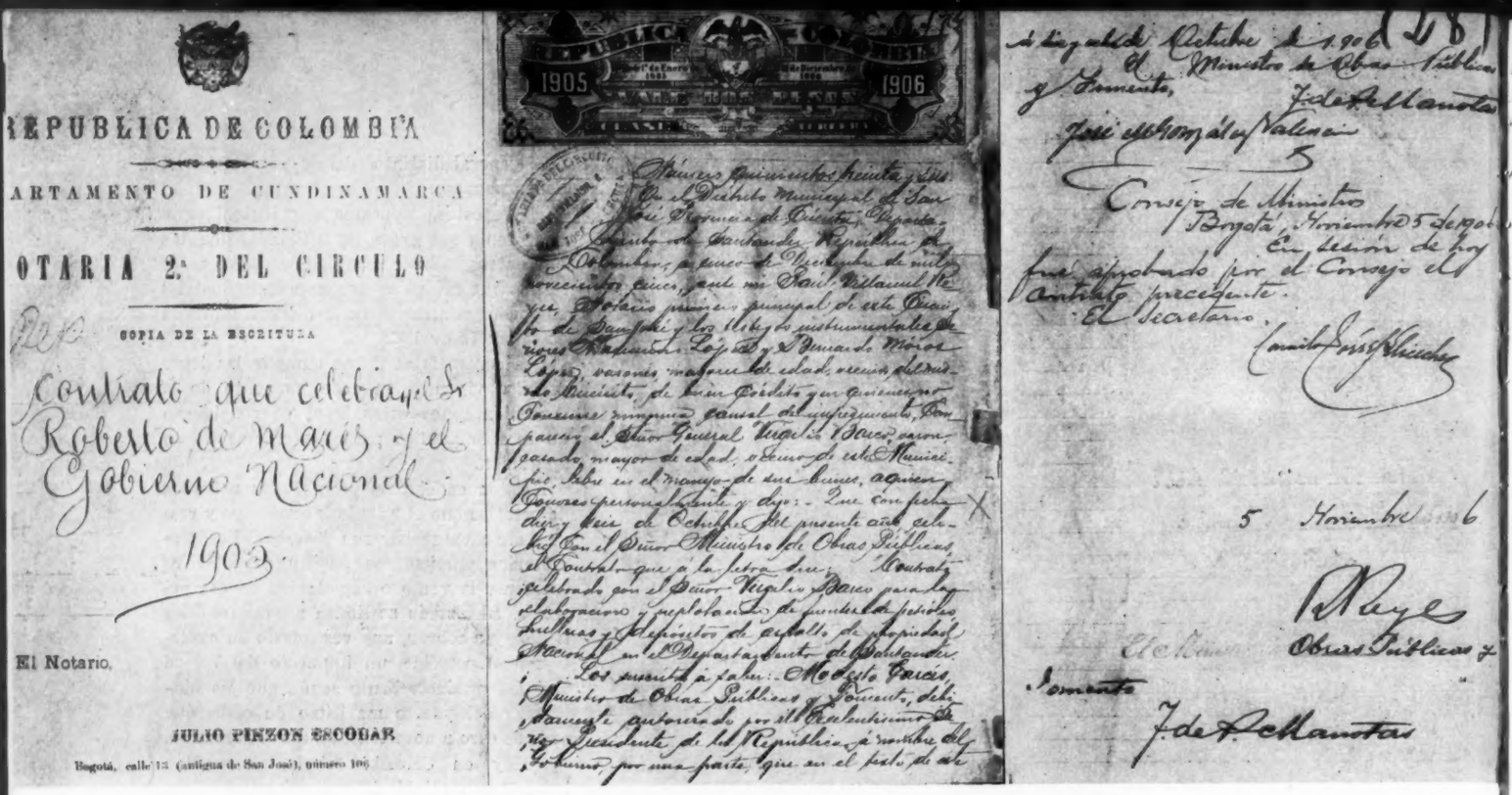
Existen en el país propiedades privadas de petróleo que el Estado las reconoce y respeta sin menoscabar sus derechos. Los propietarios particulares pueden negociar libremente la venta o explotación de ese petróleo. El Estado se limita a examinar los títulos y a cobrar, una vez puesto en explotación el petróleo, un impuesto del 7% al ½% del producto bruto según que las distancias del puerto marítimo de embarque sean de cero a novecientos o más kilómetros.

Hay en Colombia varias compañías importantes establecidas como son la Tropical Oil Company, la Colombian Petroleum Co., la Texas Petroleum Co., la Socony Vacuum Oil Co., la Andian National Corporation Ltd., la Richmond Petroleum Company, la South American Gulf Oil Co., la Shell Petroleum Co., y El Condor Oil Co.

En conjunto solamente se han concedido hasta ahora 1,750.000 hectáreas, y por publicaciones recientes en revistas extranjeras se sabe que hay Compañías que han dado orden a sus agentes de obtener el mayor número de concesiones en Colombia.

En la actualidad se sacan 20,000.000 de barriles de petróleo anuales de la Tropical Oil Co., y las concesiones de la Colombian tienen en aforos iniciales más de 10.000.000 de barriles por año, con menos de treinta pozos, con la circunstancia de que se han encontrado pozos con una producción de 8,000 barriles diarios.

Hay un vasto campo en el país de terrenos que tienen indicios petrolíferos en espera que se hagan las exploraciones y cateos del caso para conocer su potencialidad, de manera que es oportuno solicitar concesiones. Celebrado un contrata no puede ser cambiado si no por voluntad de ambas partes. El Gobierno de Colombia tiene una tradición no interrumpida en el cumplimiento de sus contratos y una organización de sus tribunales de justicia absolutamente independientes del Poder Ejecutivo, de tal manera que las cortes de justicia pueden condenar a la propia Nación a cumplir o indemnizar los perjuicios que se causen. El animo del Gobierno es el de cumplir fielmente sus compromisos, sin buscar subterfugios que puedan poner en duda su seriedad y buena fe. Asímismo exige cumplimiento honorable y limpio a las personas con quienes contrate.


REPUBLICA DE COLOMBIA

ARTAMENTO DE CUNDINAMARCA

OTARIA 2ª DEL CIRCULO

COPIA DE LA ESCRITURA

Contrato que celebran el Sr Roberto de Mares y el Gobierno Nacional

1905

El Notario,

JULIO PINZON ESCOBAR

Bogotá, calle 13 (antigua de San José), número 106

REPUBLICA DE COLOMBIA

1905 1906

Mil novecientos cinco, ante mí Raúl Villamil Re-
yes, Notario primero principal de este Circui-
to de Bogotá y los Testigos instrumentales de
vecinos Eduardo Lozada y Eduardo Mejor
Lopez, varones mayores de edad, vecinos del Dis-
trito Municipal de este Departamento, Presentes
Presente compareció el señor General Virgilio Barco, casa-
do, mayor de edad, vecino de este Municipio,
de este Departamento, a quien
conozco personalmente y dijo: Que con fecha
diez y seis de Octubre del presente año cele-
bró con el Señor Ministro de Obras Públicas
el Contrato que a la letra dice: Contrato
celebrado por el Señor Virgilio Barco para la
explotación y explotación de ciertas minas
salinas y depósitos de petróleo de propiedad
Nacional en el Departamento de Cundinamarca
Los suscritos a saber: Modesto Garcés,
Ministro de Obras Públicas y Fomento, debi-
damente autorizado por el Excelentísimo Se-
ñor Presidente de la República, a nombre del
Gobierno por una parte, que en el resto de este

Bogotá, Octubre de 1906
El Ministro de Obras Públicas
y Fomento,
J. de P. Pallanotes
José Ignacio Valencia

Consejo de Ministros
Bogotá, Noviembre 5 de 1906
En sesión de hoy
fue aprobado por el Consejo el
contrato precedente.
El Secretario,

5 Noviembre 1906

Rafael Reyes

Obras Públicas y Fomento

J. de P. Pallanotes

Left—The first page of the actual De Mares concession contract. Center—The first page of Barco concession. Right—Signature of President Rafael Reyes on Barco refining concession.

LEGAL STABILITY Indicated by History of Colombian Oil Laws

Rational Approach to Design of Oil Law Demonstrates Judicial Temperment of Nation Which Has Assured Adequate Social and Financial Returns from Oil Exploitation and Encouraged Development by Foreign Capital.

IN THE last two and a half years there has been an unmistakable revival of interest in the oil possibilities of Colombia. There has been an intensified leasing program led by Shell and Richmond, work on the famous Barco concession has proceeded rapidly, The Texas Company will soon be drilling on their Pto. Boyaca property, Socony-Vacuum has sunk one deep test and is preparing a second on the Restrepo concession in the valley. World conditions are responsible to some extent for this activity: international oil men are more conscious of decreasing flush production that may be felt in two to five years than they are of a temporary over supply.

Moreover, and perhaps most important, the system of proration now in force in the United States makes the development of oilfields abroad a more attractive proposition. In Texas and the Mid-Continent, no matter how great the potential production of a newly discovered pool, the organization responsible for the discovery may be sure that the allowable production will be strictly limited long before production has fully amortized the geological, geophysical and exploration drilling costs. From there on the payout is likely to be slow. Elsewhere in the world, if equitable laws and a judicial outlook on the part of the governments involved, protect the necessarily much larger initial investment, the oil company may look forward to unit development of their field and amortization of their investment depending only on the rate at which their wells can produce.

In view of this situation, international oil interests surveying the legislative record of countries containing definite indications of oil reserves must have been most favorably impressed by the legalistic attitude and rational approach displayed by the people of Colombia. To understand this more fully a brief review of the history of Colombian oil legislation, a glance at present developments and an analysis of one of the major future problems will be helpful.

During 1905 the two principal concessions for exploration and exploitation of petroleum were granted by the Colombian government in one case to Roberto De Mares covering an area of approximately 500,000 hectares (1,264,000 acres) in the Magdalena valley and in the other to General Virgilio Barco covering 700,000 hectares (later reduced to 200,000 hectares) in the Catatumbo region near the Venezuelan border. During this period there was no definite body of rules covering the development of petroleum resources, so that the general provisions of the Mining Code were applied to oil as they were to coal, iron and phosphate deposits. The right to exploit such deposits could only be obtained by concession-contract, the terms of which were subject to special negotiation in each case. Obviously this did not tend to encourage development of the nation's oil resources.

Before considering the second phase of Colombian oil legislation it is important to trace the history of the two main concessions.

The writer is indebted to Dr. Sady Gonzalez Bernal, Interventor de Petroleos, Dr. Francisco Escobar, former Colombian consul general in New York who assisted in the transfer of both the De Mares and Barco concessions, and Sr. James Raisbeck, Jr., for much of the factual information contained in this article.

La Historia de las Leyes Petroleras Colombianas Indica ESTABILIDAD LEGAL

El acercamiento racional al proyecto de la ley petrolera demuestra el temperamento jurídico de la nación que ha asegurado remuneración adecuada tanto social como pecuniaria de la explotación petrolera, e impulsa el desarrollo mediante capital extranjero.

Petrolea No. 1 on the Barco concession in flames many years ago.

DURANTE los últimos dos años y medio se ha notado una manifestación inequívoca de interés en las posibilidades que ofrece la industria petrolera de Colombia. Ha habido un programa intensificado de arrendamientos, encabezado por la Shell y la Richmond, el trabajo sobre la afamada concesión Barco ha procedido rápidamente, The Texas Company empezará pronto a abrir pozos en su propiedad de Pto. Boyaca, la Socony-Vacuum ha abierto un pozo de prueba, a gran profundidad, y ahora está preparando el segundo en la concesión Restrepo en el valle. Las condiciones mundiales explican en gran parte esta actividad. Los petroleros internacionales están más deseosos de disminuir la producción copiosa que tal vez se sentirá dentro de los próximos dos a cinco años, que de lograr un abastecimiento temporal excesivo.

Además, y lo que tal vez es más importante, el sistema de prorratación actualmente en vigencia en los Estados Unidos hace que el desarrollo de los campos petrolíferos en el extranjero represente una proposición más atractiva. En Tejas y el Continente Central, sin que importe la enormidad de la producción potencial de algún depósito recién descubierto, la organización que logre efectuar el descubrimiento puede estar segura de que la producción concedible será estrictamente limitada antes de que la producción haya amortizado totalmente los costos geológicos, geofísicos y de exploración y perforación. Desde entonces

El autor presenta sus más cumplidos agradecimientos al Dr. Sady González Bernal, Interventor de Petróleos, al Dr. Francisco Escobar, Ex-Cónsul General en Nueva York, y al Sr. James Haisbeck, Jr., por muchos de los datos e informaciones que han servido de base para la elaboración de este artículo.

From November 28, 1905, when the concession was granted to De Mares until 1909, De Mares endeavored to organize a group for the development of the concession. However, in 1909 the government proceeded to cancel the concession on the grounds that the concessionaire had not complied with the terms of the contract. The resolution cancelling the concession was suspended in 1915 when De Mares proved that circumstances beyond his control were responsible for his failure to fulfill his obligations under the contracts. The concession was reinstated, however, on condition that work must start within 12 months from June 25, 1915.

Notwithstanding the scarcity of men and materials caused by the Great War, the first well on the concession was, in fact, spudded in on June 14, 1916, thereby fulfilling this obligation. As a result of having settled all questions relating to performance under the contract, Tropical's position has been greatly strengthened and all other minor matters which have since arisen have been readily settled in the courts to the complete satisfaction of both parties.

The Barco concession was granted on December 5, 1905, and called for the submission of maps and studies within one year and the beginning of exploration drilling within three years.

A year later the original contract was supplemented by another authorizing the concessionaire to establish a refinery in or near Cucuta.

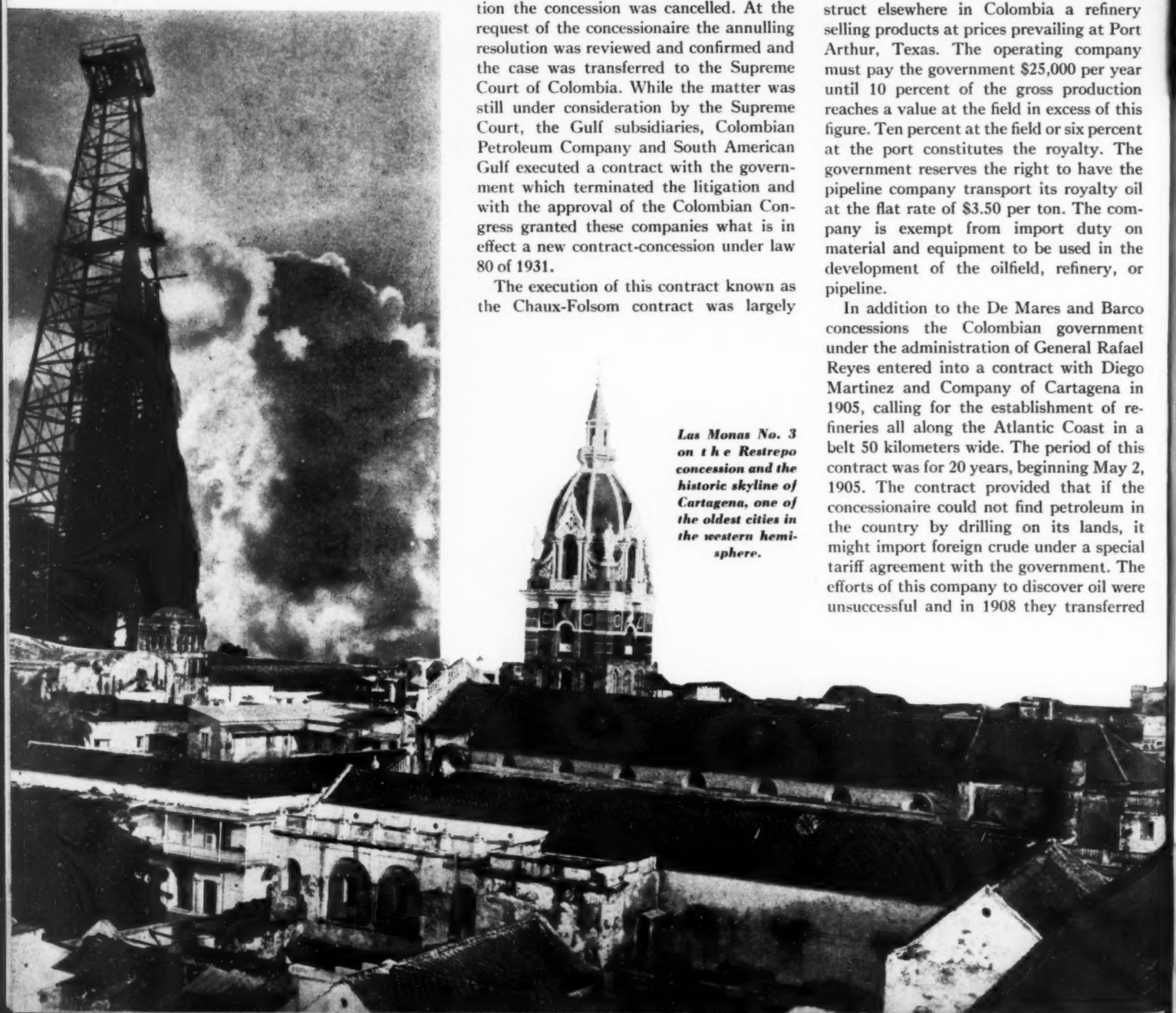
In 1917 Barco having failed to prove production, requested and received permission from the government to transfer his concession to the Colombian Petroleum Company which was then controlled by Henry L. Doherty and Company. As a result of difficulty in getting drilling equipment into the concession through Venezuela the Doherty interests sold the concession rights to South American Gulf Oil Company, a subsidiary of the Gulf Oil Corporation of Pittsburgh and at about this time (1926) during the Ospina administration the concession was cancelled. At the request of the concessionaire the annulling resolution was reviewed and confirmed and the case was transferred to the Supreme Court of Colombia. While the matter was still under consideration by the Supreme Court, the Gulf subsidiaries, Colombian Petroleum Company and South American Gulf executed a contract with the government which terminated the litigation and with the approval of the Colombian Congress granted these companies what is in effect a new contract-concession under law 80 of 1931.

The execution of this contract known as the Chaux-Folsom contract was largely the result of the untiring efforts, broad vision and careful study on the part of President Olaya Herrera.

In 1936, with the approval of the Colombian government, this concession was acquired by The Texas Corporation and Socony-Vacuum Oil Company, Inc. Since then work on the concession has been pushed forward rapidly and a pipeline from Petrolea to Covenas as well as a refinery at Petrolea will soon be completed.

The principal provisions of the Chaux-Folsom contract are: Exploitation will be confined to 200,000 hectares selected from an area of 700,000 hectares available for exploration. The contract will run for a period of 50 years and the company must keep two strings of tools running until it obtains production of 21,000 bbl. per day when it must construct a pipeline entirely through Colombian territory to tidewater within three years. When production reaches 30,000 bbl. per day the Colombian Petroleum Company must construct on the concession, or South American Gulf must construct elsewhere in Colombia a refinery selling products at prices prevailing at Port Arthur, Texas. The operating company must pay the government $25,000 per year until 10 percent of the gross production reaches a value at the field in excess of this figure. Ten percent at the field or six percent at the port constitutes the royalty. The government reserves the right to have the pipeline company transport its royalty oil at the flat rate of $3.50 per ton. The company is exempt from import duty on material and equipment to be used in the development of the oilfield, refinery, or pipeline.

In addition to the De Mares and Barco concessions the Colombian government under the administration of General Rafael Reyes entered into a contract with Diego Martinez and Company of Cartagena in 1905, calling for the establishment of refineries all along the Atlantic Coast in a belt 50 kilometers wide. The period of this contract was for 20 years, beginning May 2, 1905. The contract provided that if the concessionaire could not find petroleum in the country by drilling on its lands, it might import foreign crude under a special tariff agreement with the government. The efforts of this company to discover oil were unsuccessful and in 1908 they transferred



Las Monas No. 3 on the Restrepo concession and the historic skyline of Cartagena, one of the oldest cities in the western hemisphere.

Beautiful Cartagena bay from which tankers depart carrying Colombian oil for distribution in the world's markets.

la amortización probablemente será lenta. En otras partes del mundo, si las leyes equitativas y las perspectivas judiciales por parte de los gobiernos comprendidos protegen la inversión inicial necesariamente mucho mayor, la compañía petrolera puede acudir al desarrollo unitario de su campo y la amortización de su inversión, dependiendo sólo de la proporción en que sus pozos puedan producir.

En vista de esta situación, los intereses internacionales del petróleo que inspeccionan los registros legislativos de países que den indicaciones definidas de contar con reservas de petróleo, seguramente habrán quedado bien impresionados de la actitud jurídica y del aproximamiento racional desplegado por la población de Colombia. Para comprender ésto más a fondo, tal vez ayude pasar una revista breve a la historia de la legislación petrolera colombiana, con una ojeada a los sucesos actuales, y un análisis de uno de los principales problemas del porvenir.

Durante 1905, el Gobierno de Colombia aprobó las dos concesiones principales para la explotación del petróleo, una en el caso del Sr. Roberto De Mares, abarcando un área aproximadamente de 500,000 hectáreas (1,264,000 ácres) en el valle del Magdalena, y la otra al General Virgilio Barco, comprendiendo 700,000 hectáreas (más tarde reducidas a 200,000 hectáreas) en la región de Catatumbo, cerca de la frontera venezolana. Durante ese período no existía grupo definido de reglas relativas al desarrollo de los recursos petroleros, de modo que hubo que aplicar al petróleo las estipulaciones generales del Código Minero, de igual modo que habían sido aplicadas a los depósitos de carbón, de hierro y de fosfato. Los derechos para la explotación de tales depósitos sólo podían obtenerse mediante contratos concesionarios, cuyas condiciones quedaban sujetas a negociaciones especiales en cada caso. Por supuesto, eso no era tendiente a estimular el desarrollo de los recursos petroleros del país.

Antes de tomar en consideración la segunda fase de la legislación petrolera colombiana, es importante pasar revista a dos de las concesiones principales.

Desde el 28 de noviembre de 1905, en que se otorgó la concesión De Mares, hasta el año de 1909, el Sr. De Mares trató de organizar un grupo que se encargara de desarrollar la concesión. Pero en 1919 el gobierno procedió a cancelar la concesión, debido a que el concesionario no había cumplido con las condiciones del contrato. Sin embargo, la resolución cancelando la concesión fué suspendida en 1915, cuando De Mares demostró que el no cumplimiento de sus obligaciones contractuales se debió a circunstancias de fuerza mayor. Por consiguiente, la concesión fué restablecida, bajo la condición de que se diera principio a los trabajos antes de 12 meses a partir del 25 de junio de 1915. A pesar de la escasez de hombres y materiales causada por la guerra mundial, el primer pozo relativo a la concesión fué abierto el 14 de junio de 1916, cumpliendo así esta obligación. Como resultado de haber arreglado todos los asuntos relativos al cumplimiento bajo contrato, la posición de la Tropical Oil Company ha quedado considerablemente fortalecida, y todas las dificultades de menor importancia que han surgido desde entonces han sido fácilmente arregladas en los tribunales, a entera satisfacción de ambas partes.

La concesión Barco fué otorgada el 5 de diciembre de 1905, y estipulaba el sometimiento de mapas y estudios dentro de un año, dando principio a los trabajos de perforación de pozos en el transcurso de tres años.

Un año después, el contrato original fué suplementado con otro, autorizando al concesionario a establecer una refinería en o cerca de Cúcuta.

En 1917 Barco, habiendo dejado de cumplir con la producción comercial estipulada, solicitó y recibió permiso del gobierno para trasladar su concesión a la Colombian Petroleum Company, que entonces era dirigida por Henry L. Doherty and Company. Como resultado de dificultades en obtener equipo para la perforación de pozos en la concesión, por conducto de Venezuela, los intereses de la Doherty vendieron sus derechos de concesión a la South American Gulf

Baby clinic at Camp 22 on the De Mares concession; these illustrations represent some of the benefits to the nation that are not recorded in the account books.

Interior and exterior of the Tropical Oil Company's hospital at El Centro where competent medical service is available in the midst of the jungle.

their concession to the Cartagena Oil Refining Company.

In 1909 the Cartagena Oil Refining Company opened a petroleum refinery in the city of Cartagena and in order to supply the refinery with raw material the company began to import crude petroleum, with the object of refining it and placing the product on the domestic market.

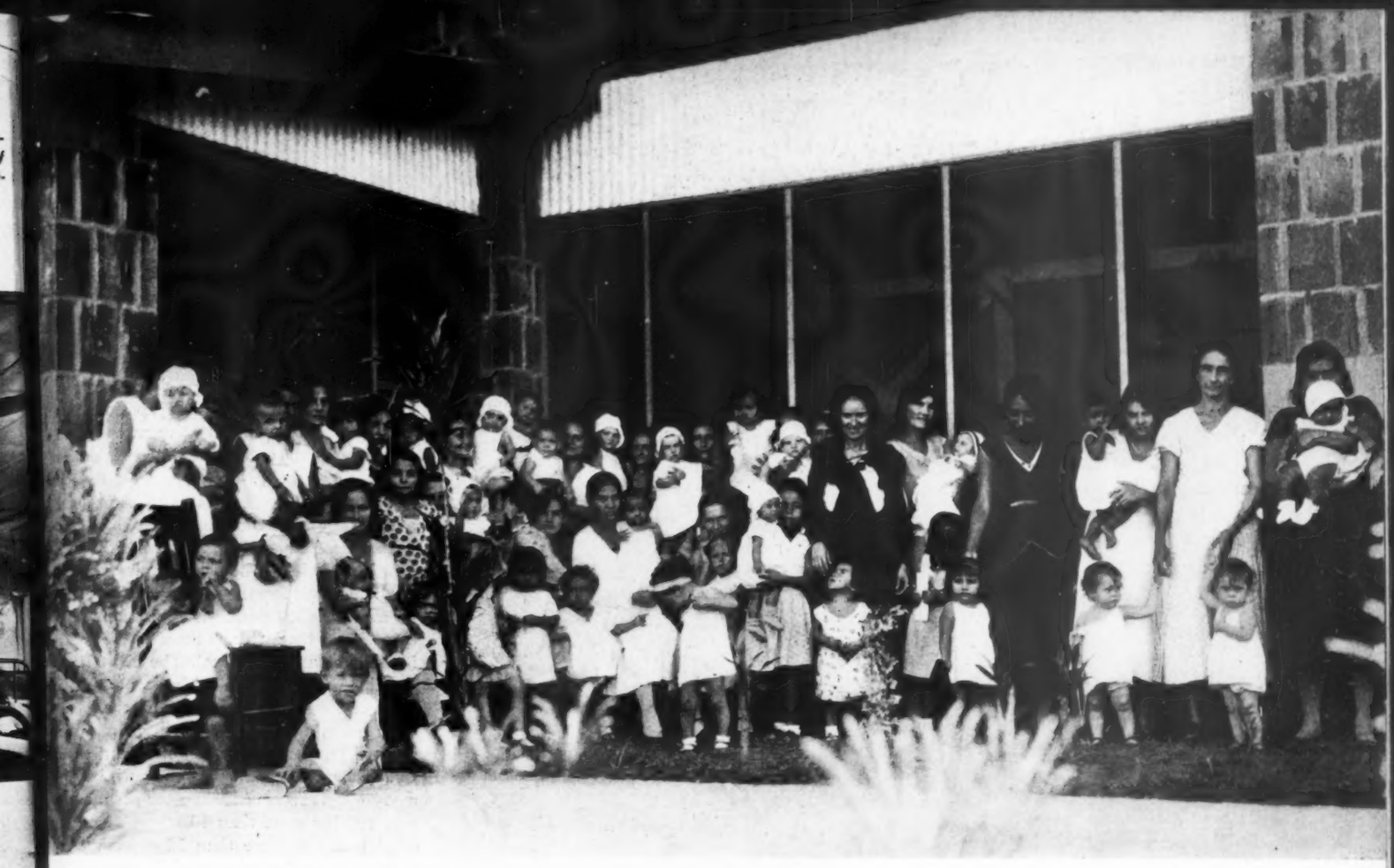
Having been established for the purpose of developing domestic crude production for the refinery the company continued its efforts to obtain national petroleum and for that purpose organized a new personnel and equipment, with which it began to drill a well in Turbaco, work which was discontinued in May, 1911. Exploration work with the drill was continued until 1913, resulting in sinking a well to the depth of 2500 ft. which, however, did not give satisfactory commercial results.

While the Cartagena Oil Refining Company was thus in full activity in 1912 the government introduced a bill for revising the oil tariff which seriously threatened the existence of the refinery. However, the Cartagena plant continued to operate until the year 1920, producing the following derivatives from imported crude: gasoline, refined petroleum, A.C.P.M., lubricants and greases. Up to the time named the company had worked 12 years without serious difficulty, but due to a controversy with the government over the interpretation of the contract the enterprise had to be liquidated. This controversy lasted about three years and was finally decided in favor of the Cartagena Oil Refining Company by judgment entered on July 30, 1923.

The lack of definite oil laws that prevailed in 1905 when the two principal concessions were granted persisted until the passage of Law 120 of 1919. Just before this, Decree 1255 had been issued but had been declared unconstitutional. Following Law 120 of 1919, Laws 14 of 1923, and 72 of 1925 were passed and under this body of legislation more than 800 applications for concessions were received but no contract for exploitation of national lands was concluded. The chief defect of this body of law was the excessive nature of the regulations and the formalities necessary to obtain concessions as well as the very limited acreage granted. Royalty payments to the nation were moreover considered too small.

Therefore during the administration of Dr. Abadia Mendez all previous applications were cancelled and authorization obtained from Congress for a commission of foreign experts to assist in drafting an adequate oil law. The commission consisted of Sir Thomas Holland from England, Dr. H. Foster Bain from the United States, Engineer Santiago Gonzalez Cordero of Mexico and Dr. Aurel Iancoulesco of Roumania. These petroleum authorities together with technical and legal experts from Colombia drafted a law for consideration by Congress which was studied in great detail and finally modified slightly with the help of George Rubblee, an authority on petroleum law from the United States. The first draft had been submitted in 1929 but it was not until 1931 that it was finally passed as Law 37. Executive Decree Number 1270 regulating Law 37 was promulgated the same year.

While this law represented a decided improvement over previous oil legislation it was not until Law 160 of 1936 was passed clarifying doubtful features, extending exploration periods, defining private property rights and simplifying judicial procedure, that really intensive development began. It must be recognized that the method followed by Colombia in achieving an equitable oil law represented an extraordinary effort to be fair to foreign investors and operators as well as to protect for her own people an irreplaceable natural resource. While the approach to the law was deliberate, every effort was made to eliminate principal defects of former laws, to secure for the nation maximum benefits and to assure ample protection and a fair return to outside investors. The main features of these laws are covered in the article by Dr. Jorge Gartner. However it is of interest to note some of the provisions that do not work out in practice as well as originally planned. In the first place a single company can obtain only 50,000



Oil Company, subsidiaria de la Gulf Oil Corporation de Pittsburgh, y como por ese tiempo (1926), durante el régimen de Ospina fué cancelada la concesión. A petición del concesionario, la resolución anulante fué revisada y confirmada, habiendo sido trasladado el caso a la Corte Suprema de Colombia. Mientras el asunto estaba bajo la jurisdicción de la Corte Suprema, los subsidiarios de la Gulf, la Colombian Petroleum Company y la South American Gulf negociaron un contrato con el gobierno que puso fin al litigio, y con la aprobación del Congreso Colombiano, se otorgó a estas compañías lo que en efecto equivale a una nueva concesión-contrato bajo la ley 80 de 1931.

La ejecución de dicho contrato, conocido como el contrato Chaux-Folsom fué en gran parte resultado de los incansables esfuerzos, previsión y minucioso estudio de parte del Presidente Olaya Herrera.

En 1936, con la aprobación del gobierno colombiano, esta concesión fué adquirida por The Texas Corporation y la Socony-Vacuum Oil Company, Inc. Desde entonces han progresado rápidamente los trabajos sobre la concesión, y pronto quedará terminado un oleoducto desde Petrolea hasta Covenas, así como una refinería en Petrolea.

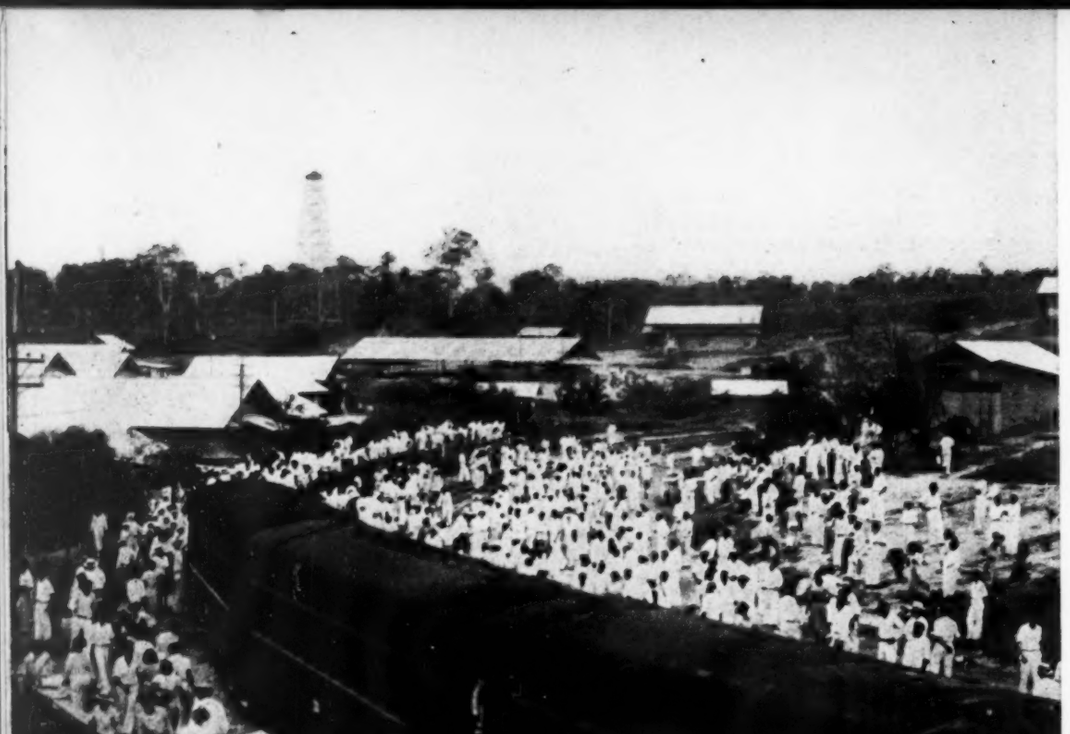
Las principales estipulaciones del contrato Chaux-Folsom son: La explotación quedará limitada a 200,000 hectáreas elegidas de las 700,000 hectáreas disponibles para la exploración. El contrato estará en vigor durante un período de 50 años, y la compañía tendrá que mantener trabajando dos equipos completos para la perforación de pozos hasta alcanzar una producción de 21,000 barriles por día, cuando habrá que construir un oleoducto enteramente por territorio colombiano hasta la costa, antes de tres años. Cuando la producción llegue a 30,000 barriles por día, la Colombian Petroleum Company deberá construir en la concesión, o la South American Gulf tendrá que construir en otra parte de Colombia, una refinería que venda productos a los precios vigentes en Port Arthur, Tejas. La compañía encargada de los trabajos debe pagar al gobierno $25,000 por año hasta que un 10 por ciento de la producción bruta llegue a un valor en el campo, en exceso de esta cifra. Diez por ciento en el campo o seis por ciento en el puerto constituye los derechos de propiedad. El gobierno se reserva al derecho de ordenar a la compañía del oleoducto que transporte su petróleo al tipo de $3.50 por tonelada. La compañía queda exenta del impuesto de importación sobre el material y equipo que se emplearán en el desarrollo del campo petrolífero, la refinería o el oleoducto.

Además de las concesiones De Mares y Barco, el gobierno colombiano, bajo la administración del General Rafael Reyes, entró en un contrato con la firma Diego Martínez and Company, de Cartagena, en 1905, estipulando el establecimiento de refinerías en la costa del Atlántico, en una zona de 50 kilómetros de ancho. El período de este contrato era de 20 años, empezando el 2 de mayo de 1905. El contrato estipulaba que si el concesionario no podía encontrar petróleo en el país al abrir pozos en sus propios terrenos, podría importar petróleo crudo extranjero bajo un acuerdo arancelario especial con el gobierno. Los esfuerzos de esta compañía para descubrir petróleo no tuvieron éxito, y en 1908 traspasó su concesión a la Cartagena Oil Refining Company.

En 1909 la Cartagena Oil Refining Company abrió una refinería de petróleo en la ciudad de Cartagena, y a fin de suministrar a la refinería materia prima, la compañía empezó a importar petróleo crudo, con el objeto de refinarlo y poner el producto en el mercado doméstico.

Habiéndose establecido con objeto de desarrollar la producción doméstica de petróleo crudo para la refinería, la compañía continuó sus esfuerzos para obtener petróleo nacional, y para ese fin organizó un nuevo personal y adquirió nuevo equipo, con el que empezó a abrir un pozo en Turbaco, trabajo que fué suspendido en mayo de 1911. El trabajo de exploración con el taladro fué continuado hasta 1913, habiendo resultado en un pozo de 2500 pies de profundidad, el que, sin embargo, no dió resultados comerciales del todo satisfactorios.

Mientras la Cartagena Oil Refining Company se encontraba así en actividad completa, en 1912 el gobierno introdujo una petición para revisar la tarifa petrolera, lo que



order to spare other companies the expense of geological, geophysical and survey work preceding the filing of an application on lands that have already been applied for.

Additional difficulties arise as a result of the somewhat confused title situation as regards private lands but it is not clear how the government could facilitate the proving of titles any more than they have already done. Delays in granting drilling permits and delays in acting on applications for concessions are administrative rather than legislative and no doubt will be eliminated as work progresses.

Colombia possesses far-reaching social and welfare legislation, much of which has been passed since 1930. A definite distinction is made in law between employees and laborers, the former being classified as persons whose work is predominantly mental and the latter as those whose work is predominantly physical. The eight hour working day is established by law and it is expressly stated that under similar circumstances no rights or privileges may be granted foreign employees not accorded to Colombians. No industrial enterprise with a payroll in excess of 1,000 pesos per month may employ more than 10 percent foreign employees nor more than 20 percent foreign laborers. A minimum of 70 percent of the employee payroll must go to Colombians and not less than 80 percent of the laborers payroll likewise must be paid to Colombian workmen. Colombian employees and workmen are entitled to payment in the same currency as is paid to foreign employees and workmen. Employees are entitled to 15 days vacation per year at full

Above—Workmen from the El Centro camp embark for the ride to Barranca Bermeja on Saturday afternoon on the company railroad. Below—A sample of the rough going in clearing for locations.

hectares direct from the government plus an additional 50,000 hectares by transfer from a third person. In the case of lands lying east of the Eastern Cordillera a single company is allowed a maximum of 200,000 hectares. With only about eight major companies in the world possessing adequate resources, organizations and markets necessary in successfully undertaking an immensely costly and laborious development, such as involved in Colombia, the area in active exploration and exploitation would be limited to 800,000 hectares, a small fraction of the Republic's prospective area now accessible.

While of minor importance, the question occasionally arises why the government refuses to divulge areas on which applications are already pending. It is not, of course, considered necessary to publish the name of the applicant, but simply to indicate the area under consideration in

amenazó seriamente la existencia de la refinería. No obstante, la refinería de la Cartagena continuó trabajando hasta el año de 1920, produciendo los siguientes derivados del petróleo crudo importado: gasolina, petróleo refinado, A.C.P.M., lubricantes y grasas. Hasta la fecha mencionada, la compañía había trabajado 12 años sin seria dificultad, pero debido a una controversia con el gobierno sobre la interpretación del contrato, la empresa tuvo que disolverse. Esta controversia duró cerca de tres años, y finalmente fué decidida en favor de la Cartagena Oil Refining Company, según fallo registrado el 30 de julio de 1923.

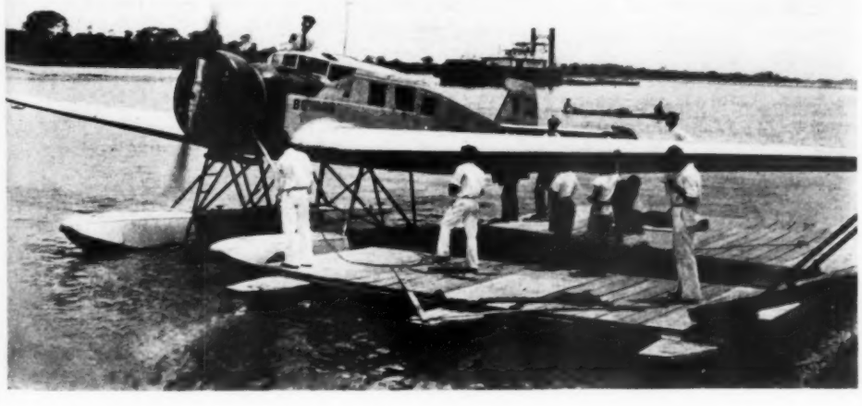
La falta de leyes petroleras definidas en 1905, en que se otorgaron las dos concesiones principales, persistió hasta aprobarse la ley 120 de 1919. Precisamente antes de ésto se había expedido el Decreto 1255, pero había sido declarado inconstitucional. Después de la Ley 120 de 1919, se aprobaron las Leyes 14 de 1923, y la 72 de 1925, y bajo este grupo legislativo se recibieron más de 800 aplicaciones sobre concesiones, sin haberse firmado ningún contrato para la explotación de terrenos nacionales. Los principales defectos de este grupo de leyes fueron la naturaleza excesiva de las regulaciones y las formalidades necesarias para obtener concesiones, así como el número tan limitado de acres que se concedió. Los pagos por derechos de propiedad a la nación fueron considerados, además, insignificantes.

Por lo tanto, durante la administración del Dr. Abadía Méndez fueron canceladas todas las aplicaciones previas, habiéndose obtenido autorización del Congreso para formar una comisión de expertos extranjeros que ayudara a trazar una ley petrolera adecuada. La comisión consistía de Sir Thomas Holland, de Inglaterra; el Dr. H. Foster Bain, de los Estados Unidos; el Ingeniero Santiago González Cordero, de México; y el Dr. Aurel Iancoulesco, de Rumanía. Estas autoridades petroleras, en unión de expertos técnicos y juristas de Colombia, trazaron una ley para someterla a la aprobación del Congreso, el que después de estudiarla detenidamente la modificó un poco, con la cooperación de George Rubblee, distinguida autoridad sobre leyes petroleras de los Estados Unidos. El primer proyecto fué sometido en 1929, pero no fué sino hasta 1931 cuando finalmente fué aprobado como la Ley 37. El Decreto Presidencial Número 1270 regulando la Ley 37 fué promulgado ese mismo año.

Aunque esta ley representaba una mejora decidida sobre la legislación petrolera anterior, no fué sino hasta que se pasó la Ley 160 de 1936 aclarando los detalles dudosos, extendiendo los períodos de exploración, definiendo los derechos de propiedad privada, y simplificando el procedimiento judicial, cuando se dió principio al desarrollo verdaderamente intenso. Hay que reco-

Some of the essential health work in cutting down the incidence of malaria at El Centro.

Plane, steamboat and dugout canoe at Puerto Wilches on the Magdalena; the extensive system of scheduled air routes in Colombia has meant much in opening up areas hitherto inaccessible.



salary and to a maximum of 120 days sick leave at half salary.

Employees who are discharged without adequate cause are entitled to cecentia—one month's salary for each year of service. Due to the stipulation that employers cannot introduce testimony of other employees to establish the fact that an employee was discharged for cause and because there are seldom other witnesses available on an oil concession, the payment of cecentia occasionally works an injustice on employers. It seems not unlikely that steps may be taken to modify this provision in the interest of equity that is so apparent in most provisions of Colombian law.

Any foreigner who has resided ten or more years in Colombia or who has married a Colombian national is considered a Colombian for the purposes of the labor law.

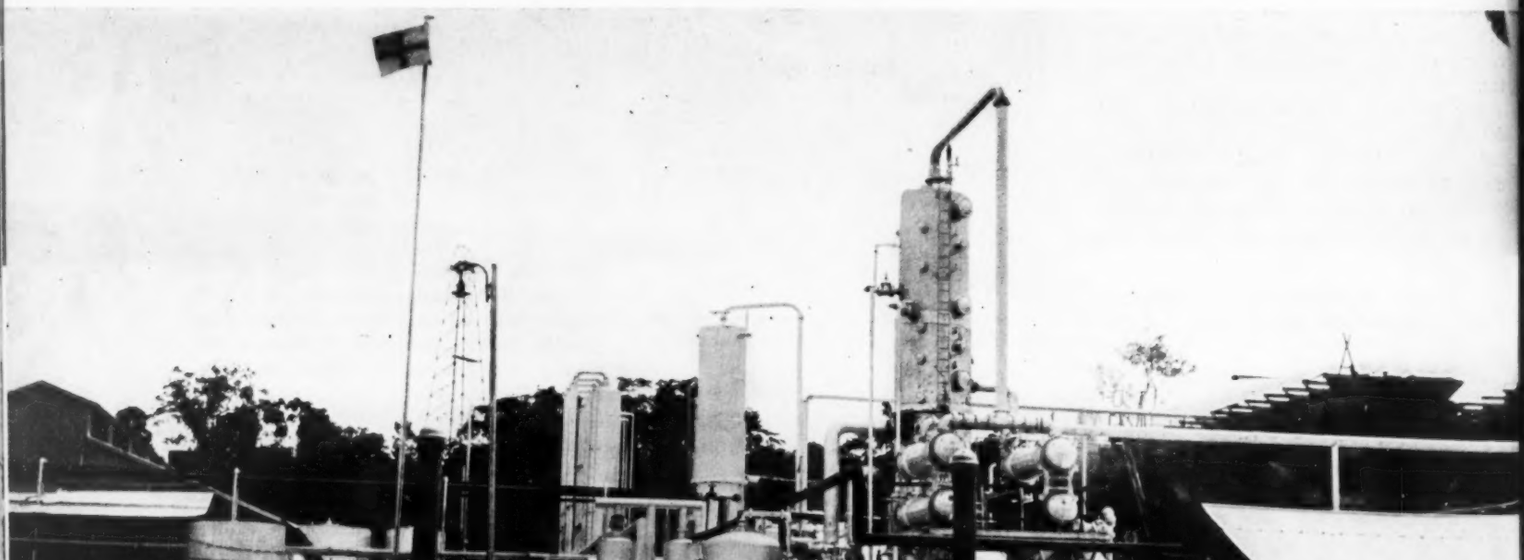
Law 83 of 1931 recognizes the right of employees or workmen to organize and stipulates a minimum of 25 members as constituting a union. Employers are granted the same right to organize with a minimum of five members to form a union of employers. Unions are expressly prohibited from participating in politics and are forbidden to use names that may suggest a political affiliation.

Resolution number 251 of 1937 under the Department of Hygiene refers to oilfield camps and governs selection of camp sites, sanitary services, building materials, light, ventilation, etc.

It is of interest to consider how the nation has profited by the development of the oil industry. To date commercial production has been obtained only on the De Mares concession of the Tropical Oil Company but that organization has exported during 1937 a quantity of 17,731,799 bbl. of oil valued at $20,825,997 f.o.b. Mamonal in U.S. currency. Against this gross return they imported material into Colombia valued at 5,947,094 pesos, paid out 3,291,176 pesos in wages in Colombia plus 47,418 pesos in pension bonuses and disability compensation. The company paid an additional 425,591 pesos for medical, educational, recreational and housing facilities. To the government the company paid 10 percent royalty amounting to 2,449,824 pesos and 3,483,617 pesos in taxes on refined products. Approximately 5,000,000 pesos were paid in income, partrimony, and excess profits tax. Therefore the company has spent in Colombia a minimum of 20,644,720 pesos or approximately $11,797,000. Deducted from the gross return at Mamonal this leaves $9,028,997 plus or minus any profit or loss arising from refining and distributing 2,783,074 bbl. of crude in Colombia. Considering that product prices under Tropical's contract must not exceed the highly competitive New York City prices refining operations probably do not show much if any profit. Out of the remaining amount the company must, of course, amortize an investment of well over $100,000,000 U.S. and meet that part of home office expense that may be properly allocated to Colombian operations.

From the point of view of the nation the development of this one concession returned in the single year 1937 over 20,000,000 pesos, the entire country was supplied with petroleum products at about the lowest price in South America, a large body of

The natural gasoline plant at El Centro.



An example of the frame houses used by married staff members at the oil camps.

nocer el hecho de que el método seguido por Colombia para llegar a una ley petrolera equitativa representaba un esfuerzo extraordinario de ser equitativa a los capitalistas y explotadores extranjeros así como de proteger para su propio pueblo, una riqueza natural insubstituíble. Aunque el aproximamiento a la ley fué deliberado, se hicieron todos los esfuerzos posibles por eliminar los defectos de las leyes anteriores, a fin de obtener para el país los beneficios máximos y asegurar amplia protección y utilidades justas a los capitalistas extranjeros. Los detalles característicos de esta ley se encontrarán descritos en el artículo del Dr. Jorge Gartner. Sin embargo, será de interés notar algunas de las estipulaciones que no resultan en la práctica tan bien como se había proyectado originalmente. En primer lugar ninguna compañía puede obtener más de 50,000 hectáreas directamente del gobierno, además de 50,000 hectáreas adicionales por traspaso de una tercera persona. En el caso de los terrenos que quedan al este de la Cordillera Oriental, se permite a una sola compañía un máximo de 200,000 hectáreas. En vista de que sólo hay como ocho compañías grandes en el mundo que poseen recursos adecuados, organizaciones y los mercados necesarios para efectuar con éxito un desarrollo inmensamente costoso y laborioso, tal como el comprendido en Colombia, el área de exploración y explotación activa sería limitado a 800,000 hectáreas — sólo una pequeña fracción del área explorable de la república, con que actualmente se cuenta.

Aunque de menor importancia, a veces se presenta la cuestión de por qué el gobierno rehusa divulgar áreas sobre las que ya existen aplicaciones pendientes. Por supuesto no se considera necesario publicar el nombre del solicitante, sino simplemente indicar el área que se tiene en consideración, con objeto de ahorrar a otras compañías el costo de los trabajos de inspección geológica y geofísica precedente a la aplicación sobre terrenos acerca de los que ya se han hecho aplicaciones.

Otras dificultades se presentan como resultado de la situación algo confusa sobre títulos con respecto a terrenos privados, pero no se sabe cómo podría facilitar el gobierno la comprobación de títulos más de lo que ha hecho hasta ahora. Las demoras en autorizar permisos para la perforación de pozos y las demoras en actuar sobre aplicaciones relativas a concesiones, son administrativas más bien que legislativas, y sin duda desaparecerán a medida que el trabajo progrese.

Colombia posee importantísimas leyes sociales y para el bienestar general, muchas de las cuales han sido aprobadas desde 1930. En la ley se hace una distinción marcada entre los empleados y los trabajadores, pues los primeros se clasifican como personas cuyo trabajo es predominantemente mental, mientras que los segundos son aquellos cuyo trabajo es predominantemente físico. El día de trabajo de ocho horas ha sido establecido por la ley, y se manifiesta expresamente que bajo circunstancias similares no podrán otorgarse derechos ni privilegios a los empleados extranjeros, no acordados a individuos colombianos. Ninguna empresa industrial cuya nómina exceda de 1,000 pesos al mes podrá emplear más de 10 por ciento de empleados extranjeros ni más de 20 por ciento de trabajadores extranjeros. Un mínimo de 70 por ciento de la nómina para los empleados debe pasar a colombianos, y no más de 80 por ciento de la nómina de los trabajadores, de igual modo, debe pagarse a los trabajadores colombianos. Los empleados y los trabajadores colombianos tienen derecho a recibir su pago en la misma moneda en que se pague a los empleados y trabajadores extranjeros. Los empleados tienen derecho a 15 días de vacaciones cada año, con sueldo completo, y a un máximo de 120 días por enfermedad, a medio sueldo.

Los empleados que son despedidos sin causa justificable tienen derecho a cesantía — un mes de salario por cada año de servicios. Debido a la estipulación de que los jefes no pueden introducir testimonio de otros empleados para establecer el hecho de que un empleado fué despedido con razón, y de que rara vez se cuenta con otros testigos en las concesiones petrolíferas, el pago de cesantía resulta frecuentemente injusto para los jefes. No parece improbable que se lleguen a tomar los pasos necesarios para modificar esta estipulación en interés de la justicia que es tan aparente en casi todas las estipulaciones de la ley colombiana.

Cualquier extranjero que haya permanecido en Colombia diez o más años o que se case con colombiana, será considerado como natural de Colombia para los fines de la ley del trabajo.

La Ley 83 de 1931 reconoce el derecho de

Nevado del Tolima, 5620 meters elevation, as seen through the clouds by a Scadta photographer; this peak is snow-covered the year around.

Colombian workmen received work as well as trade and technical education.

As indicative of the position of workmen on the concession, taking 1926 as a base year with earnings and 15 staple food items at the company's commissary in that year as equal to 100, earnings had increased to 147 by 1937 while the cost of foods had decreased to 86.

Assuming that development of other fields in Colombia will bring similar benefits in employment, medical care, sanitation, education and government revenue the value of an administrative and legislative program designed to encourage development of the oil resources would seem fully justified.

Already the question is much discussed in government circles as well as elsewhere in Bogota as to the proper policy to adopt in regard to refining. The Tropical possesses sufficient refining capacity to supply present domestic needs. Under the Chaux-Folsom contract Colombian Petroleum Company will erect a refinery on the Barco concession capable of supplying that area. Should the government encourage the construction of excess refining capacity in order to stimulate exportation of refined products rather than crude oil?

Obviously until the present trend in the oil policy of consuming countries is modified, the construction of excess refining capacity in Colombia would represent an economic waste that must eventually be reflected in the return to the companies operating there or to the government or to both. In the United States refining capacity is sufficiently over-developed and the tariff situation is such that refined products can be imported only at a loss. In France, Italy, Germany and Great Britain national oil policy is directed toward the building up of a domestic refining industry. The same policy prevails in Japan. The trend is therefore toward rigid exclusion of refined products while the importation of crude is encouraged. The world market for refined products has been constantly narrowing for the past decade while the market for crude has broadened in proportion. It would seem therefore highly uneconomic for a country like Colombia to enter this world competition for a domestic refining industry when all indications are that the crude market will be far better maintained for the immediate future.

los empleados o los trabajadores a organizarse, y estipula un mínimo de 25 miembros para formar una unión. Los empleados tienen el mismo derecho de organizarse, con un mínimo de cinco miembros para formar una unión de empleados. Las uniones tienen prohibición terminante de participar en asuntos políticos, ni tampoco podrán usar nombres que insinúen alguna afiliación política.

La resolución número 251 de 1937 del Departamento de Higiene, se refiere a los campos de petróleo y gobierna la selección de sitios, servicios sanitarios, materiales para construcciones, alumbrado, ventilación, etc.

Es de interés considerar hasta dónde se ha beneficiado la nación mediante el desarrollo de la industria petrolera. Hasta ahora, se ha obtenido la producción comercial sólo en la concesión De Mares de la Tropical Oil Company, pero esa organización ha exportado durante 1937 una cantidad de 17,731,799 barriles de petróleo, por valor de $20,825,997 f.o.b. Mamonal, en dólares. Contra esta retribución bruta, importó material a Colombia por valor de 5,947,094 pesos, pagó 3,291,176 pesos en salarios en Colombia, además de 47,418 pesos en pensiones y compensación por incapacidad. La compañía pagó la suma adicional de 425,591 pesos por facilidades médicas, educativas, recreativas y de albergue. Al gobierno la compañía pagó 10 por ciento por derechos de propiedad, que ascendieron a 2,499,824 pesos, y 3,483,617 pesos en impuestos sobre productos de petróleo refinado. Aproximadamente 5,000,000 de pesos fueron pagados en impuestos sobre ingresos, patrimonio y utilidades excesivas. Por lo tanto la compañía ha gastado en Colombia un mínimo de 20,644,720 pesos, o sea aproximadamente $11,797,000. Deducido de la retribución bruta en Mamonal, ésto deja $9,028,997, además o menos cualquier ganancia o pérdida resultante de refinar y distribuir 2,783,074 barriles de petróleo crudo en Colombia. Considerando que los precios del producto bajo el contrato con la Tropical Oil Company no deben exceder de los precios neoyorquinos altamente competitivos, los trabajos de refinación probablemente mostrarán poca o ninguna ganancia. De la cantidad restante la compañía debe amortizar, por supuesto, una inversión que excedae de 100,000,000 de dólares, y satisfacer la parte de gastos de la oficina principal que pueda asignarse debidamente a las operaciones colombianas.

Desde el punto de vista de la nación, el desarrollo de esta concesión produjo en el año de 1937 más de 20,000,000 de pesos, todo el país fué abastecido de productos de petróleo, al precio más bajo cotizado en Sud-América y una gran cantidad de trabajadores colombianos recibieron trabajo, así como instrucción comercial y técnica.

Como indicación de la posición de los trabajadores en la concesión, tomando 1926 como base, con ingresos y 15 productos alimenticios esenciales en el comisariato de las compañías en ese año como igual a 100, las ganancias habían subido a 147 en 1937, mientras el costo de los alimentos había descendido a 86.

Suponiendo que el desarrollo de los otros campos en Colombia trajera beneficios similares en empleo, cuidado médico, sanidad, educación e ingresos gubernamentales, el valor de un programa administrativo y legislativo destinado a estimular el desarrollo de los recursos petroleros parecería estar ampliamente justificado.

Actualmente está discutiéndose mucho el asunto en círculos gubernamentales así como en todo Bogotá, en cuanto a los planes adecuados que deben adoptarse con respecto a la refinación. La Tropical Oil Company posee suficiente capacidad refinadora para satisfacer las demandas domésticas actuales. Bajo el contrato Chaux-Folsom, la Colombian Petroleum Company eregirá una refinería en la concesión Barco, capaz de abastecer a esa área. ¿Debe el gobierno fomentar la construcción de capacidad refinadora en exceso, con objeto de estimular la exportación de productos refinados más bien que la del petróleo crudo?

Evidentemente, mientras no se modifique la tendencia actual en los planes petroleros de los países consumidores, la construcción de una capacidad para refinar en exceso en Colombia representaría un derroche económico que eventualmente se reflejaría en la remuneración a las compañías que trabajen allá, al gobierno, o a ambos. En los Estados Unidos, la capacidad para refinar está lo suficientemente desarrollada, y la situación arancelaria es tal que los productos refinados sólo pueden importarse con pérdida. En Francia, Italia, Alemania y la Gran Bretaña, los planes petroleros nacionales se dirigen a la formación de una industria refinadora doméstica. Los mismos planes se siguen en el Japón. La tendencia es, por lo tanto, hacia la exclusión rígida de los productos refinados, mientras que la importación de petróleo crudo es fomentada. El mercado mundial por productos refinados ha venido disminuyendo constantemente durante la última década, mientras que el mercado por el petróleo crudo se ha ensanchado proporcionalmente. Por lo tanto, parece resultar sumamente improductivo para un país como Colombia entrar esta competencia mundial por una industria refinadora doméstica, cuando todo parece indicar que el mercado por el petróleo crudo podrá mantenerse mucho mejor durante el porvenir inmediato.

Colombian Statistics

(U.S. bbl. of 42 gals.)

	Production	Run to Stills	Exports
1921	66,750	.....	.....
1922	322,786	199,091	.....
1923	424,875	340,615	.....
1924	444,744	295,489	.....
1925	1,006,708	587,022	.....
1926	6,443,537	737,101	4,638,377
1927	15,009,175	1,506,499	13,677,477
1928	19,895,677	1,474,642	17,910,168
1929	20,384,547	1,667,761	18,600,467
1930	20,345,916	1,230,034	19,112,813
1931	18,237,190	1,260,392	16,989,070
1932	16,417,125	945,363	15,321,540
1933	13,157,641	780,501	11,805,701
1934	17,340,724	1,395,691	16,477,383
1935	17,597,654	1,413,908	15,949,331
1936	18,756,109	2,059,716	16,436,950
1937	20,297,846	2,384,689	17,731,799
1938	21,581,588	2,769,224	18,535,044

Tankage at the head of the Petrolea-Covenas pipeline; note tank under construction in right foreground.

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A village in the foothills of the Eastern Andes on the road from Bogota to Cucuta.

ECONOMIC ASPECTS of Oilfield Exploitation in Colombia

By E. Ospina-Racines
First Vice Consul of Colombia in Charge of Petroleum Affairs in New York

E. Ospina-Racines.

Of the South American countries which are expected to play an important future role in the supply of oil to world markets and as a potential oil reserve, Colombia may be singled out as one of the most promising territories for development.

Today the search for oil and potential oilfields is worldwide. Through efforts of international oil companies and as result of policies pursued by Governments, oil prospecting has been promoted and extended to many countries with consequent discoveries of very promising fields. This activity and the changing situation with respect to the United States which no doubt eventually will become the foremost importer of petroleum may be clearly seen in the data of a decade presented in Table I.

From the data presented in Table I it will be seen that the past decade has brought about many discoveries of oil producing fields and that these discoveries have taken place in the ratio of about four to one outside the United States.

The countries of the world may be classified into three categories, namely, countries of balanced production and consumption, producing countries and consuming countries. The present position of Colombia in relation to the oil producing countries of the world is shown in the accompanying Table II. Some interesting facts are revealed by listing not only the production of the various countries but also their corresponding consumption. As may

TABLE I

	Production in thousands of barrels, year 1927	1937	Percent Increment in 10 years
World Mundial	1,262,582	2,038,928	61.5
United States Estados Unidos	901,129	1,277,653	29.6
Other Countries Otros Paises	361,453	761,275	110.0

Aspectos Económicos de la Explotación del Petróleo en Colombia

Por E. Ospina Racines, Primer Vicecónsul de Colombia, Encargado de los Asuntos Petroleros en Nueva York.

ENTRE los países de Sud América que se espera desempeñarán un papel importante en el abastecimiento de petróleo a los mercados mundiales y como reserva potencial de petróleo, Colombia se destaca como una de las regiones de desarrollo más prometedor.

Actualmente la búsqueda de petróleo y campos petrolíferos es universal. Debido a los esfuerzos de compañías petroleras y como resultado de la política que siguen los Gobiernos, se han fomentado y extendido las exploraciones en muchos países, dando por resultado el descrubimiento de yacimientos muy prometedores. Esa actividad y la situación que viene desarrollándose respecto a los Estados Unidos, los que sin duda llegarán a ser los mayores importadores de petróleo, puede verse claramente por las cifras de una década, presentadas en la tabla I.

Por los datos que se presentan en la mencionada tabla se aprecia que la última década ha traído muchos descubrimientos de yacimientos productores de petróleo y que esos descubrimientos se han efectuado a razón de cuatro a uno en territorio fuera de los Estados Unidos.

Los países del globo pueden clasificarse en tres categorías, a saber: países productores cuya producción y consumo están equilibrados; países productores; y países consumidores. El puesto que ocupa Colombia respecto de los países productores de petróleo en el mundo puede verse en la tabla II. Hechos interesantes y sorprendentes se revelan al citar no sólo la producción de los países sino también el consumo correspondiente de éstos. Como puede apreciarse, el papel de un país productor en el tráfico internacional de petróleo llega a ser importante solo en proporción al exceso que tenga disponible para la exportación, después de abastecer al mercado propio.

En relación con la tabla II, los países productores del mundo figuran en orden cronológico de acuerdo con el año cuando se alcanzó a producir el primer millón de barriles. La tabla muestra que Colombia es uno de los países productores más recientes, pues obtuvo el primer millón de barriles anuales en 1926.

Entre los países que figuran ahí, los Estados Unidos es el único que puede clasificarse como país de equilibrada producción y consumo. En un próximo futuro la Unión Soviética pueda que llegue a esta categoría. Los otros doce países de la lista son los países productores del mundo. Los países consumidores de mayor importancia son los países europeos, Gran Bretaña, Francia, Alemania, Italia, Suecia, Bélgica y además el Canadá, Brasil, Argentina y el Japón. El consumo de éstos y de los países de menor importancia se señala en la tabla por la cifra de 514,597,000 barriles que se titula, consumo de "Otros Países".

Se observará que los países productores por sí tienen un consumo apreciable. Los Estados Unidos consumieron en 1937 una

TABLE II

Colombia in Relation to Producing Countries and World Oil Market Data for the Year 1937 Expressed in Thousands of Barrels

Producing Countries and First Year of One Million Barrels of Oil Production	Year	Production	Consumption	Consumption Percentage of Indigenous Production	Resulting Available Quantity for Export	Percent of World Total Available for Export
Bahrein	1935	7,762	....	..	7,762	1.6%
Iraq	1932	30,604	3,760	12%	27,844	5.8
COLOMBIA	1926	20,998	2,453	12	17,845	3.7
Venezuela	1921	187,675	8,320	5	179,355	36.5
Trinidad	1917	15,503	4,530	30	10,973	2.1
Iran	1913	78,109	8,940	11	69,169	14.0
Peru	1909	17,457	2,750	16	14,707	3.0
Mexico	1907	46,456	21,590	46	24,866	5.2
Roumania	1899	52,176	12,400	24	39,776	8.1
Netherland India	1895	54,113	11,300	22	42,813	8.5
Poland	1895	3,800	2,800	74	1,000	0.2
Soviet Union	1876	201,857	158,200	79	45,657	9.3
United States	1861	1,277,653	1,167,900	92	9,753	2.0
Other Countries		45,465	514,597	..		
Totals		2,038,928	1,919,540	99%	491,470	100.0%

Production data from World Petroleum.
Consumption data from Garfias, Whetsel & Ristori, Feb. 1938, A.I.M.E.

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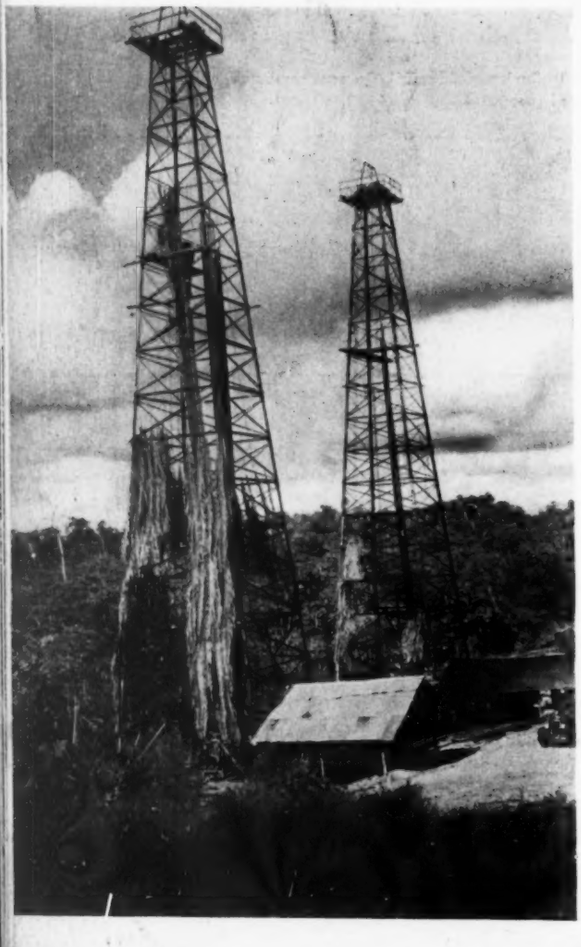

Above, the center of Socony-Vacuum's Aguas Claras camp in the Middle Magdelena Valley: left, Las Monas No. 1 which produces 18 bbl. per day and No. 14, dry hole, on the Restrepo Concession.

be appreciated, the role of a producing country in international petroleum trade is important only in proportion to the excess it may have available for export, after meeting its domestic requirements.

Referring to Table II, the oil producing countries of the world are listed according to the year when the first million barrels of oil production was obtained. The table reveals that Colombia is one of the most recent producing countries, its first one million barrels yearly production being attained in 1926.

Among the countries, the United States is the only one that may be classified as one of balanced production and consumption. The immediate future may see the Soviet Union in this category. The other twelve countries listed are the producing countries of the world. The major consuming countries are the European nations, Great Britain, France, Germany, Italy, Sweden, Belgium and in addition Canada, Brazil, Argentina and Japan. The consumption of these and minor countries is shown in the table as 514,597,000 bbl. referred to as consumption of "Other Countries."

It will be noted that the producing countries have an appreciable consumption. The United States consumed in 1937 an amount equivalent to 92.0 percent of the indigenous production; Mexico 46 percent; Trinidad 30 percent; Colombia refined for domestic consumption some 2,376,000 bbl. and imported 76,000 bbl. of refined products. Its consumption is, therefore, equivalent to 12 percent of the indigenous production.

The total net available quantity for export is shown as 491,470,000 bbl. This figure is obtained by substracting the consumption from the corresponding production figure, however, it does not refer to actual exports. Nevertheless, the available export figures give an indication of the total available oil which must necessarily attend to the demand created by the consuming countries. The international trade demand for crude oil is equivalent to the consumption listed as "Other Countries" less the production these countries obtain. In 1937 the international trade demand was equivalent to 514,597,000 bbl. less 45,465,000 bbl. or a demand of 469,132,000 bbl.

cantidad equivalente al 92 por ciento de su producción autóctona; México el 46 por ciento; Trinidad el 30 por ciento; en Colombia, se elaboraron unos 2,376,000 y se importaron 76,000 barriles de productos refinados. El consumo luego equivale al 12 porciento de la producción autóctona.

La cantidad neta total disponible para la exportación se señala por la cifra de 491,-470,000 barriles. Esta cifra se obtiene restando el consumo de la cifra de producción correspondiente, pero el saldo así obtenido no se refiere a las exportaciones efectuadas. Sin embargo, el saldo que se denomina como el total disponible para la exportación sirve de indicio de la cantidad de petróleo que necesariamente tiene que abastecer a la demanda de los países consumidores. La demanda creada por el tráfico internacional de petróleo equivale al consumo que se señala ahí como consumo de "Otros Países" menos la pequeña cantidad que producen esos países. En 1937 la demanda internacional ascendió a 514,597,000 barriles, menos los 45,465,000 producidos, o sea una demanda neta de 469,132,000 barriles de petróleo.

De la cantidad de 491,470,000 de barriles disponibles para la exportación, que suple esa demanda, Venezuela suministró el 36.5 porciento; Irán el 14 porciento; y la Unión Soviética el 9.3 porciento. Cabe anotar que de esa cantidad Colombia suministró el 3.7 porciento, a pesar de que su producción de petróleo en 1937 solo alcanzó al uno por ciento de la producción mundial.

De lo expuesto, es aparente que solo basta un pequeño porcentaje de cambio en el abasto y demanda internacional de petróleo para establecer condiciones en el mercado que favorezcan al desarrollo de terrenos petrolíferos prometedores. De los cinco países productores más recientes que suministran la mayor parte de la cantidad exportable, tres están situados en Sur América septentrional. Dentro de ese área, Colombia tiene terrenos de mucha promesa.

ZONAS PETROLIFERAS

El territorio de Colombia de perspectiva petrolífera comprende áreas bien definidas. La geología del país indica que tales terrenos se encuentran en las hoyas de los ríos principales como lo enseña el mapa que aparece aquí. Las zonas, en orden de importancia, son así: (1) La hoya del río Magdalena, en donde se halla el único yacimiento productor (2) La hoya del río Catatumbo, actualmente en activo estado de desarrollo y que da indicios de llegar a ser una región productora de mayor importancia. (3) Los Llanos, que se extienden del pié de la Cordillera oriental hacia el río Orinoco, en donde he han otorgado varias concesiones, también se han arrendado varias extensiones de terreno particular y una región muy prometedora. (4) Las sabanas del litoral del Caribe, en donde hace unos dieciocho años se hicieron exploraciones con taladro, que aunque no dieron resultado positivo, tampoco puede considerarse definitivo. (5) La costa meridional del litoral del Pacífico, región que pueda ser la continuación de las zonas petrolíferas del Ecuador y Perú.

REGALÍA

El artículo 31 de la ley sobre petróleos establece las regalías que deben pagarse al explotar concesiones de propiedad nacional. La tabla III muestra la relación entre la distancia del puerto marítimo y la regalía pagadera. Los porcentajes que figuran en la columna E, Tabla III, son pagaderos en el puerto, según la distancia máxima que figura en la columna B. El Gobierno tiene la opción de exigir la regalía en especie en el centro de recolección del campo. En tal caso, el concesionario entregará al Gobierno el porcentaje de acuerdo con la columna E, mas la cantidad de petróleo crudo que equivalga al valor del transporte de esa participación desde el centro de recolección hasta el puerto de embarque marítimo. La cantidad adicional de petróleo crudo que debe entregarse al Gobierno por causa del trans-

Right, Motilone Indian hut in a jungle clearing on the Eastern slope of the Andes: Below, preparing to cross the Rio Zuila en route to Petrolea on the Barco.

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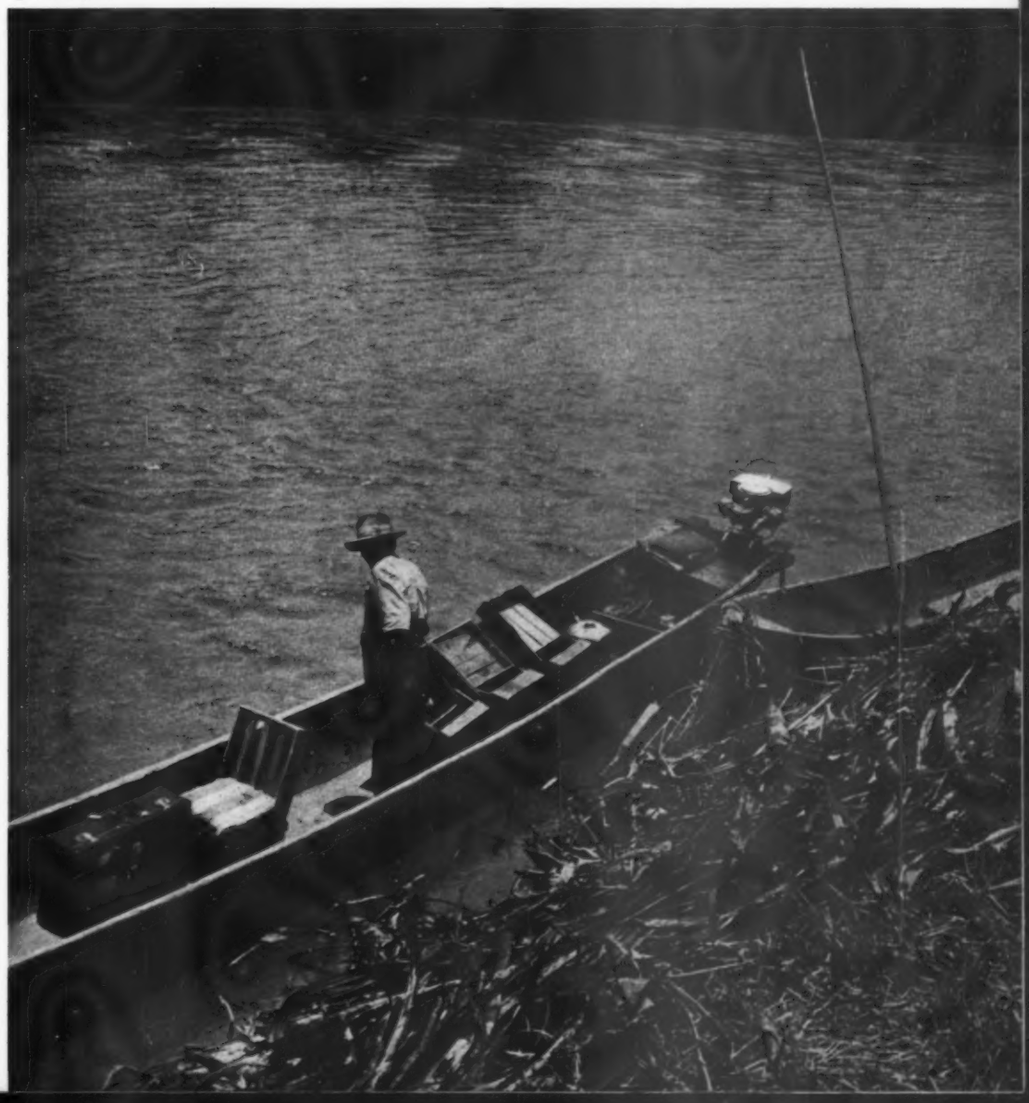


Of the net available quantity for export of 491,470,000 bbl. which supplies the consuming countries, Venezuela furnished 36.5 percent; Iran furnished 14 percent; the Soviet Union accounted for 9.3 percent. It is interesting to note that of this quantity Colombia furnished 3.7 percent although its 1937 oil production amounted to only one percent of world production.

It is apparent that only a small percentage change in the world supply and demand of crude oil is necessary to create market conditions which will favor the development of prospective oil lands. Of the five most recent producing countries listed, which furnish the bulk of the available export quantity, three of these are in northern South America. Within this area Colombia contains very promising prospective lands.

OIL REGIONS

The prospective oil land of Colombia is located in well defined regions. The geology of the country indicates that such oil land is located in the drainage areas of the principal rivers, as shown in the accompanying land classification map. These regions are in their order of importance; (1) Magdalena River basin, wherein is located the only producing field; (2) The Catatumbo River basin, which is under active development and promises to become an important producing region; (3) The Llanos or great eastern plains extending from the foot of the Eastern Cordillera toward the Orinoco River, where various national concessions have been granted, private lands leased, an area of much promise; (4) The Caribbean coastal plains where exploratory drilling was carried out some eighteen years ago, which, while not productive cannot be considered conclusive; (5) The southern Pacific coastal region, which seems to be a continuation of the oil zones of Peru and Ecuador.

ROYALTY

Article 31 of the petroleum law establishes the royalty payments for oil concessions granted on national lands. Table III has been drawn up listing the royalty payable together with the corresponding distance of the particular field from the maritime port of shipment as stipulated in Article 31. The percentages under column E, table III, are payable at the port according to the distance, under column B. The Government has the option of requiring the royalty payment in kind at the center of the gathering system of the concession. In such case, the concessionaire shall deliver to the Government the percentage, according to column E, plus an amount of crude petroleum equivalent to the cost of transportation of such participation from the center of the gathering system of the producing field to the port of shipment. The additional amount of crude petroleum to be delivered to the Government on account of transportation shall be determined by dividing the cost of such transportation by the price of one barrel of crude petroleum of the particular field.

Article 39 of the petroleum law provides that pipeline tariffs are to be established by mutual agreement between the Government and the concessionaire operating the pipeline, taking into consideration reimbursement of the capital invested, maintenance, management, operating expenses and a fair profit. The prevailing bases for establishing pipeline rates in other countries, will be considered.

The significance of the provisions mentioned may be appreciated by taking an illustrative case, as shown in table III, which is based on a price of $1.20 per barrel at the maritime port of shipment and straight pipeline tariff rate of $0.000566 per barrel kilometer.

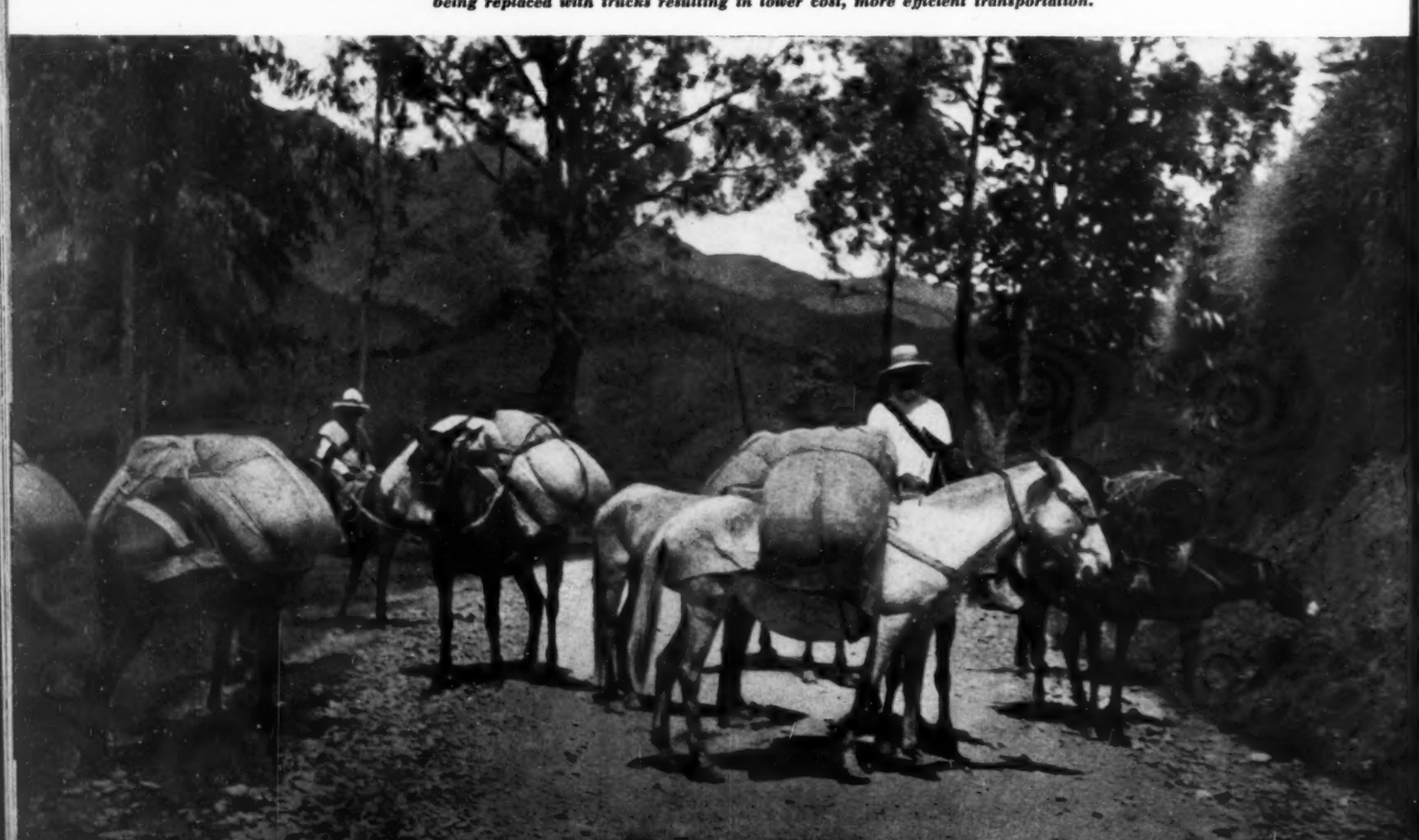
The price per barrel of $1.20 is obtained from the average f.o.b. Mamonal price since 1926. The average is $1.23 and deducting the present loading charge of 2.8 cents per barrel, as provided in Article 34, gives the figure used.

The straight rate figure $0.000566 per barrel kilometer which is used for illustrative purposes in this general discussion is obtained from the prevailing pipeline tariff of 55 centavos per barrel, transported 540 kilometers from El Centro, at present the only producing field, to Mamonal, the terminal of the pipeline. The average rate of exchange of 1.80 for 1938 has been utilized for conversion to dollars.

The pipeline contract of 1923 provides for a maximum tariff charge of 40 centavos per barrel up to the first 100 kilometers and an additional 5 centavos per 100 kilometers thereafter up to 800 kilometers.

Referring to table III, the royalty at the port, column E, varies inversely as the

Coffee has been one of Colombia's principal industries for many years; this picture shows a coffee caravan not far from Medellin. Mules are now being replaced with trucks resulting in lower cost, more efficient transportation.



The above scene of road building on the De Mares concession illustrates some of the difficulties encountered in developing a field in the jungle.

porte se determinará dividiendo el costo del transporte por el precio de un barril de petróleo en el campo de que se trate.

El artículo 39 de la ley estipula que las tarifas de los oleoductos se fijarán por mutuo acuerdo entre el Gobierno y el concesionario del oleoducto, o explotadores de petróleo de propiedad privada, teniendo en cuenta la amortización del capital invertido, costo de sostenimiento, de administración y explotación, y una ganancia equitativa para el empresario. Las bases que se utilizan para fijar las tarifas de oleoductos en otros países, y especialmente en los Estados Unidos, se tendrán en cuenta.

Puede apreciarse el significado de las disposiciones mencionadas tomando un caso ilustrativo, como se ve en la tabla III, que se ha elaborado a base de un precio de $1.20 por barril en el puerto de embarque marítimo y la tarifa de oleoducto fija de U. S. $0.000566 por barril-kilómetro.

El precio de U. S. $1.20 por barril se obtiene del precio promedio ponderado f. o. b. Mamonal desde 1926. El precio durante este período es de U. S. $1.23 y deduciendo el costo actual de trasiego en el puerto, de 2.8 centavos U. S., como lo dispone el artículo 34, se obtiene el precio utilizado.

La tarifa fija de U. S. $0.000566 por barril-kilómetro que se emplea en esta discusión general, se obtiene de la tarifa vigente de 55 centavos por barril transportado 540 kilómetros desde El Centro, actualmente el único campo productor, hasta Mamonal término del oleoducto. Para la conversión a dólares se ha utilizado el tipo de cambio promedio de 1938 de 1.80.

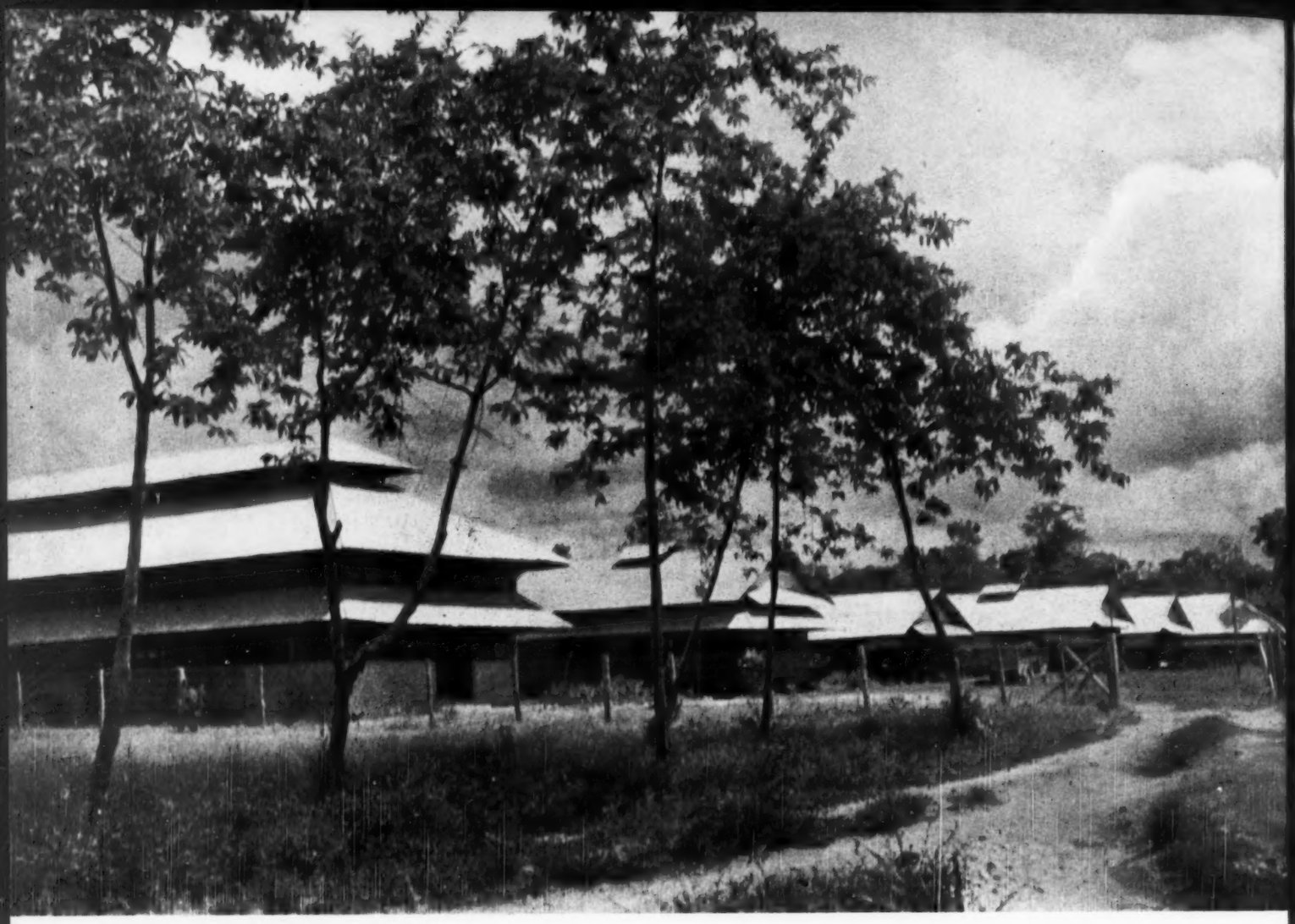
El contrato del oleoducto de 1923 autoriza una tarifa máxima de 40 centavos por barril para los primeros 100 kilómetros y 5 centavos adicionales por cada 100 kilómetros siguientes, hasta los 800 kilómetros.

En relación con la tabla III, la regalía pagadera en el puerto, columna E, varía inversamente con la distancia del campo al puerto, columna B, en kilómetros, o la de A en millas. La tarifa fija mencionada da el costo correspondiente por barril en la co-

TABLE III

Illustrative Relation Between Royalty Payable and Corresponding Distance from Seaboard Based on a Price at Maritime Port of Shipment of $1.20 per Barrel and a Straight Pipeline Tariff Rate of $0.000566 per Barrel-Kilometer.

Distance from Seaport		Pipeline Tariff U.S. Cents Per Barrel	Resulting Price at Field per barrel	Royalty Payable		Tax on Private Exploitation In Lieu of Royalty
Miles	Kilometers			Port	Field	
A	B	C	D	E	F	G
62	100	5.66	$1.143	11%	11.55%	7.00%
124	200	11.32	1.087	10	11.04	6.00
186	300	16.98	1.030	9	10.48	5.00
248	400	22.64	.974	8	9.86	4.00
310	500	28.30	.917	7	9.14	3.00
372	600	33.96	.860	6	8.37	2.00
434	700	39.62	.804	5	7.46	1.50
496	800	45.28	.747	4	6.42	1.00
558	900	50.94	.691	3	5.22	0.75
620	1000	56.60	.634	2	3.79	0.50
682	1100	62.26	.577	2	4.16	0.50
744	1200	67.92	.521	2	4.61	0.50
806	1300	73.58	.464	2	5.17	0.50
868	1400	79.24	.408	2	5.88	0.50
930	1500	84.90	.351	2	6.84	0.50



Quarters of the engineering and geological staff at Socony-Vacuum's Aguas Claras camp. The latest type of tropical buildings are used in this comfortable camp which occupies a beautiful setting in the Magdalena Valley.

distance of the field from the port, column B, in kilometers or A in miles. The straight pipeline tariff rate mentioned gives the corresponding charge per barrel in column C. Since the price at the port is $1.20, the price at the field is obtained, according to Article 34, by deducting the transportation column C giving the field price as shown in column D. Column F is the percentage equivalent required in kind, according to Article 31, when the royalty is payable at the field. Column G is the tax on private exploitation in lieu of royalty payments.

The relation of the factors F to C, D and E as noted and P, the price at port of shipment, may be expressed algebraically as follows: $F = E\ (P/P\text{-}C)$. The nature of this relation is such that the lower the price at the port the higher may be the royalty payable at the field and of course vice versa. It may be observed also that E remains constant beyond 900 kilometers which is of particular significance for concessions located in the Llanos oil regions and those of the upper Magdalena valley.

It is of interest to show the royalty payable when the value of P becomes a minimum, which of course makes F, the royalty payable at the field a maximum. As an example, in 1933, when world prices for crude oil were at their lowest, the f.o.b. Mamonal price was $0.76. The port price, P, would then be $0.73, deducting the 2.8 cents per barrel loading charge. A concession granted under Law 37 of 1931 located 540 kilometers from port would, therefore, pay a royalty at the field computed as follows: $F = 6\ (73/73\text{-}30.5) = 10.3$ percent.

GRAPH

The location and distance from seaboard of an oilfield in the interior of Colombia is a direct economic factor in the capital investment required, pipeline investment, transport tariff, pipeline tax on common carriers and also in the royalty payable to the Government.

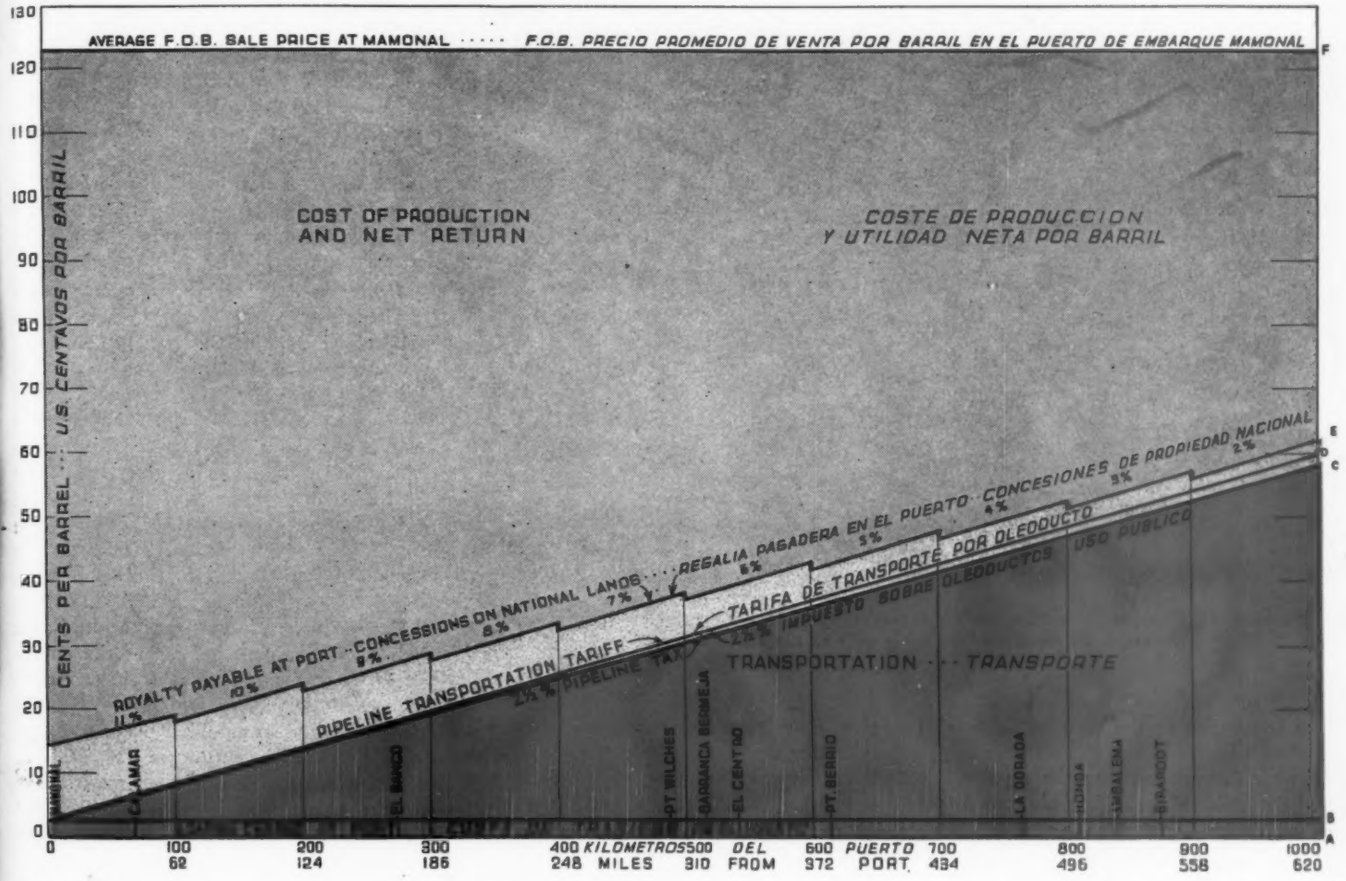
In order to illustrate how the various factors mentioned enter into the exploitation of an oilfield in Colombia according to its location in the interior, reference is made to the accompanying graph.

Line A shows the distance along the Magdalena valley from the present port of oil shipments, Mamonal. The ordinate axis shows values in cents per barrel. Line F is the f.o.b. sale price at the port of $1.23, or the average price since 1926 for shipments from Mamonal. During this period the maximum price quoted was $2.03 per barrel in 1926 and the minimum reached $0.76 per barrel in 1933.

Line B is located at the 5 centavos level or 2.78 cents which corresponds to the present loading charge at the port.

Line D is the pipeline transportation charge based on a straight rate of $0.000566 per barrel-kilometer. From this charge according to article 42, 2½ percent of the prevailing transportation tariff is payable as a tax on common carriers. This tax is shown by line C which is in direct ratio to the tariff or distance inland.

Line E is the diminishing royalty payable at the port for concessions granted on national lands. According to Article 35 the exploitation of private lands is subject to a tax payable in the same manner as the royalty of concessions on national lands.


AVERAGE F.O.B. SALE PRICE AT MAMONAL ····· F.O.B. PRECIO PROMEDIO DE VENTA POR BARRIL EN EL PUERTO DE EMBARQUE MAMONAL
CENTS PER BARREL ··· U.S. CENTAVOS POR BARRIL
COST OF PRODUCTION AND NET RETURN
COSTE DE PRODUCCION Y UTILIDAD NETA POR BARRIL
ROYALTY PAYABLE AT PORT ·· CONCESSIONS ON NATIONAL LANDS ···· REGALIA PAGADERA EN EL PUERTO · CONCESIONES DE PROPIEDAD NACIONAL
PIPELINE TRANSPORTATION TARIFF
TARIFA DE TRANSPORTE POR OLEODUCTO
2½% PIPELINE TAX
2½% IMPUESTO SOBRE OLEODUCTOS USO PUBLICO
TRANSPORTATION ··· TRANSPORTE
KILOMETROS DEL PUERTO
MILES FROM PORT
MAMONAL
CAMAR
EL BANCO
PT. WILCHES
BARRANCA BERMEJA
EL CENTRO
PT. BERRIO
LA DORADA
HONDA
GIRARDOT

lumna C. Siendo el precio en el puerto de U. S. $1.20 el precio en el campo se obtiene, según el artículo 34, restando el transporte, Columna C, lo que da el precio en el campo como lo enseña la columna D. La columna F señala el porcentaje equivalente que se requiere en especie cuando la regalía se paga en el campo.

La relación matemática entre los factores mencionados, F, C, D, E, y P, el precio en puerto, puede expresarse así:

$$F = E(P/P\text{-}C)$$

Según esta relación matemática, cuanto más bajo sea el precio en el puerto, mayor llega a ser la regalía, pagadera en el campo y por tanto vice versa. Es de notarse también que E permanece constante más allá de los 900 kilómetros, lo cual es de importancia para las concesiones situadas en los Llanos y en la región del alto Magdalena.

Sería de interés mostrar el resultado cuando P llega a un mínimo, lo cual hace F, la respectiva regalía en el campo, un máximo. Por vía de ejemplo, en 1933, cuando el precio mundial del petróleo estaba a su nivel más bajo, el precio f. o. b., Mamonal fué de $0.76. El precio en el puerto, P, luego sería de $0.73 deduciendo el costo de trasiego de 2.8 centavos U. S. por barril. Una concesión otorgada de acuerdo con la ley 37 de 1931, situada a 540 kilómetros del puerto, pagaría, luego, una regalía en el campo calculada así: F = 6 (73/73-30.5) = 10.3 por ciento.

GRÁFICO

La ubicación y por tanto la distancia del mar de un yacimiento petrolífero es un factor decisivo en la inversión de capital para la explotación, influye directamente en la tarifa de transporte por oleoducto, en el impuesto sobre oleoductos de uso público y además fija la regalía pagadera al Gobierno. Con el fin de ilustrar de que manera intervienen los distintos factores mencionados en la explotación de un campo petrolífero en Colombia, de acuerdo con su distancia del puerto, se hace referencia al gráfico que se acompaña.

La abscisa, la rectilínea A, muestra la distancia a lo largo del valle del Magdalena, desde el actual puerto de embarque de petróleo, Mamonal. La ordenada enseña los valores en centavos U. S. por barríl. La rectilínea F, señala el precio f. o. b. en el puerto, de $1.23 o el precio promedio ponderado desde 1926 en Mamonal. Durante este período el precio máximo cotizado fué de U. S. $2.03 por barril en 1926, y el mínimo alcanzó a U. S. $0.76 por barril en 1933.

La línea B se halla al nivel de 5 centavos o sean 2.78 centavos U. S. por barríl, el costo de trasiego actual en el puerto al tipo de cambio de 1.80.

La línea D indica la tarifa del oleoducto a razón de U. S. $0.000566 por barril kilómetro. De la tarifa correspondiente, según el artículo 42, se paga un impuesto del 2½ por ciento sobre oleoductos de uso público. Este impuesto está indicado por la línea C, el cual varía directamente según la tarifa o distancia del puerto.

La línea E muestra la regalía disminuyente pagadera en el puerto, sobre concesiones de propiedad nacional. Según el artículo 35, la explotación del petróleo de propiedad particular está sujeta a un impuesto, cobrado y liquidado en la misma forma establecida para la regalía del Estado. El impuesto varía según la distancia del puerto y se señala en la tabla III.

La diferencia señalada en el gráfico entre la regalía y el precio de venta f. o. b. en el puerto equivale a la utilidad neta, inclusive el costo de producción. Este último factor necesariamente tiene que comprender gastos de sostenimiento, de administración, agotamiento, depreciación, costo de adquirir la concesión, amortización y pagos por concepto de impuestos.

IMPUESTOS

Además de la regalía, la ley 81 de 1931, complementada por la ley 78 de 1935 esta-

Above, Bachelor mess hall in rear and swimming pool in foreground at Barranca Bermeja: Below, one of the early wells on the Barco concession.

The tax varies as the distance from port as shown in Table III.

The difference between the royalty line and the f.o.b. sale price is equivalent to the net return per barrel plus the cost of production. The latter must necessarily include operating expenses, administration, depletion, depreciation, cost of acquiring the concession, amortization, and tax payments.

TAX PROVISIONS

In addition to royalty payments, Law 81 of 1931 as amended by Law 78 of 1935 establishes income, excess profits and patrimony taxes as additional contributions by exploiting companies.

According to Article 13 of the oil law, concessionaires are exempt from paying all municipal and departmental taxes either direct or indirect, also from the river tax. In addition, crude petroleum, its products and by-products, are exempt from any export tax or duty during the first 30 years. Exemptions are not granted on import duties except as provided by Article 9 of Law 160 of 1936 which covers process equipment and machinery for the construction of refineries.

In connection with the above legislation it is of interest to know that the company exploiting the De Mares concession made an income tax payment in 1937 equivalent to 13.94 cents per barrel of production. This total comprised income tax of 9.13, excess profits tax of 3.55 and patrimony of 1.26 cents per barrel. Import duties equalled 1.10 and miscellaneous taxes amounted to 0.40 cents per barrel produced. The gross production in 1937 amounted to 20,297,846 bbl. of crude oil and 682,201 bbl. of natural gasoline. Some 2,376,659 bbl. of crude were refined for domestic consumption.

The company exploiting the 335 mile pipeline, from El Centro to Mamonal, transported 17,945,128 bbl. of crude and made an income tax payment in 1937 equivalent to 6.50 cents per barrel transported. This total comprised income tax of 4.23, excess profits of 1.69 and patrimony of 0.58 cents per barrel. Import duties equalled 0.28 and miscellaneous taxes paid by the pipeline company amounted to 0.08 cents per barrel transported.

Currency devaluation has taken place during recent years in many countries. In oil producing nations it has very significant economic effects. Colombia has now established by Law 167 of 1938 the gold content of the peso as 0.56424 g. of 0.900 fine. When this law became effective the legal ratio of the dollar to the peso was raised from 1.03 to 1.75. Companies which are making dollar investments now in Colombia particularly in oil production, are favored in certain instances by this circumstance. Besides having the effect of reducing in dollar equivalent import duties established heretofore, and in diminishing the outlay made as payments for national services, it reduces those payments or sums fixed by the oil law and its regulatory decree.

In practically every case reduction in actual amount of import duty paid results from the fact that imports are classified and duty collected on a weight rather than an ad valorem basis.

With reference to payments under the oil law, Article 19 and its amendment fixes a surface rental fee on national concessions varying from 10 centavos to two pesos according to the duration of the exploration period. Article 64 of the regulatory decree stipulates a minimum investment of 500,000 pesos during each five years of the first decade of the exploitation period. In view of the devaluation the rental fee is reduced from the limits of 9.7 cents to $1.94 to the limits of 5.7 cents to $1.14 per hectare per year. Likewise the minimum investment is reduced from $486,000 to $286,000. Such devaluation also affects the sums mentioned in Article 10, fixing the fee for the storage of royalty oil; in Article 11, establishing minimum deposits covering concession contracts; in Article 32, the payment to the Government for natural gas sold.

The foregoing analysis indicates that the world trend is toward a more intensive development of prospective oil lands outside the United States. Colombia is particularly favored to participate in this trend due to geological, economic and political factors. Colombia already occupies seventh place as an oil supplier and its extensive prospective oil areas suggest that it may soon move to a more prominent position. The provisions of the oil law have a noteworthy degree of equity.

blece el impuesto sobre la renta, exceso de utilidades y patrimonio, y llegan a ser contribuciones adicionales al fisco por parte de las compañías explotadoras.

Según el artículo 13 de la ley de petróleos, la exploración y explotación del petróleo quedan exentas del pago de toda clase de impuestos municipales y departamentales, directos e indirectos, lo mismo que del impuesto fluvial. También el petróleo crudo y sus derivados gozan de la exención de todo impuesto de exportación durante los primeros treinta años de la respectiva explotación. No se conceden exenciones del pago de los impuestos de aduana de importación salvo lo dispuesto en el artículo 9 de la ley 160 de 1936, el cual cubre las importaciones de maquinaria para refinerías y para el montaje de éstas.

En relación con lo dispuesto es de interés notar que la compañía explotadora de la concesión De Mares en 1937 hizo un pago de 13.94 centavos U. S. por barril explotado por concepto del impuesto sobre la renta. Este total comprende 9.13 centavos de impuesto sobre la renta; 3.55 centavos de exceso de utilidades; 1.26 centavos de patrimonio. Los derechos de aduana durante este mismo año, ascendieron a 1.10 centavos y otros impuestos nacionales a 0.40 de centavo por barril explotado. La producción bruta explotada en 1937 fué de 20,297,846 barriles de petróleo crudo y 682,201 barriles de gasolina natural. Se elaboraron en la refinería 2,376,659 barriles para el mercado interno.

La compañía explotadora del oleoducto de 540 kilómetros, desde El Centro a Mamonal, transportó 17,945,128 barriles de petróleo en 1937 e hizo un pago de 6.50 centavos U. S. por barril transportado por concepto del impuesto sobre la renta. Este total comprende 4.23 centavos de impuesto sobre la renta; 1.69 centavos de exceso de utilidades; 0.58 centavos de patrimonio. Los derechos de aduana ascendieron durante este mismo año a 0.28 de centavo y otros impuestos nacionales a 0.08 de centavo U. S. por barril transportado.

DESVALORIZACIÓN MONETARIA

La desvalorización monearia es una medida que ha venido adoptándose durante los últimos años en muchos países. En los países productores de petróleo tal medida puede tener un efecto económico de importancia. En Colombia se ha fijado nuevamente, según la ley 167 de 1938, el contenido de oro de un peso en 0.56424 g. de oro a la ley de 0.900. Esta disposición que ya ha entrado en vigencia fija el tipo de cambio legal entre el dólar y el peso y hace subir éste del 1.03 al 1.75. Las compañías industriales que en la actualidad están haciendo inversiones en dólares, y especialmente en la producción del petróleo, encontrarán ciertas ventajas en vista de esta circunstancia.

Augering for geological samples in typical Colombian jungle clearing: Shell and Richmond as well as Socony-Vacuum have done much geological work through the Magdalena Valley.

Además de tener el efecto de obtener una reducción en su equivalencia en dólares de los derechos de aduana ya fijados y el de disminuir los pagos hechos por concepto de servicios nacionales, también llega a reducir los pagos, o sumas fijadas en la ley del petróleo y en su decreto reglamentario.

La reducción de los derechos de aduana se llega a obtener debido a que prácticamente en todo caso las importaciones están clasificadas y los derechos se cobran a base del peso del artículo y no ad valórem.

En relación con los pagos fijados por la ley del petróleo, el artículo 19 y la enmienda establece un canon superficiario sobre concesiones de propiedad nacional que varía de diez centavos hasta dos pesos por hectárea, según la duración del período de exploración. El artículo 64 del decreto reglamentario estipula una inversión mínima de 500,000 pesos durante cada cinco años de la primera década del contrato. En vista de la devaluación el canon superficiario se reduce de los límites en dólares de 9.7 centavos a $1.94 a los límites de 5.7 a $1.14 por héctarea por año. Así mismo la inversión mínima se reduce de U. S. $486,000 a $286,000. La devaluación también afecta las distintas sumas; la del artículo 10, fijando el valor de almacenaje de la regalía; las del artículo 11, respecto del depósito para garantizar el cumplimiento de los contratos sobre concesiones; la del artículo 32, el pago al Gobierno por concepto de ventas del gas natural para fines industriales.

RESUMEN

El análisis anterior demuestra que se está experimentando mundialmente un desarrollo intenso de terrenos petrolíferos y que tal desarrollo está llevándose a cabo principalmente en territorio fuera de los Estados Unidos. Debido a los distintos factores geológicos, económicos y políticos, Colombia se encuentra en una posición halagadora, respecto a este desarrollo. Colombia ya ocupa el séptimo puesto como país abastecedor de petróleo, y los extensos terrenos de perspectiva petrolífera auguran que dentro de breve tiempo ocupará una posición de mayor importancia. La ley sobre el petróleo contiene disposiciones de alta equidad. Todos estos factores han de influir, sin duda, en un próximo desarrollo intenso de la industria petrolífera de Colombia.

INDUSTRIAL CENTER IN COLOMBIAN JU

Unit Operation, Efficient Refining, Well - Organized Transport and Distribution, Complete Sanitary Measures and Effective Labor Relations Make Tropical Oil Company's Operations Model for Petroleum Exploitation.

SOME 400 years ago a small but indomitable band of conquistadores rested near the banks of the Magdalena in what is now the Republic of Colombia. The scene must have been one of suspended animation for the company, clad in heavy armour, carrying cumbersome weapons, had completed 360 miles of their incredible journey through the sweating jungle. They had poled their canoes and hacked their way through all but impenetrable forests half pushing, half dragging unwieldy European horses. Bodies of their comrades were strewn down the valley behind them. Weary but erect guards maintained constant watch over the few remaining horses, objects of extraordinary care since Quesada, commander of the expedition, had decreed that the four men assigned to each horse must pay with their lives for the loss of the animal entrusted to their care.

Somewhere in the camp natural curiosity must have triumphed over weariness for soldiers brought to Don Quesada a peculiar substance they had found not far from the camp. It was a black viscous fluid and might have been recognized by Marco Polo or the Crusaders of an earlier age. To the commander it meant little: he was in quest of fabulous stores of gold. Moreover he had just received news of much greater moment: twins had been born to the Royal House of Spain. In honor of this event, the encampment was named Infantas.

Oil had been discovered at the great Infantas field, but the Spanish soldiers pushed on in quest of a better-understood wealth and the rich deposits remained undisturbed for another four centuries.

In 1905 the two great Colombian concessions were under consideration by the government in Bogota. General Barco was a familiar figure in the government buildings where he was busy clearing up details in regard to his concession in the Catatumbo. De Mares, a French engineer, equally familiar in the capital, had just received a concession to an extensive area in the Magdalena Valley near the town of Barranca Bermeja including the site of Quesada's camp.

There followed discouraging years for the concessionaire when many times his dreams of a rich oilfield on his concession must have appeared to be growing ever more remote. His persistence was rewarded in 1916, however, when a prominent group of Pittsburgh oil men organized the Tropical Oil Company, surveyed the concession and located and drilled three producing wells, proving the existence of an important reserve of petroleum. The tremendous difficulty of penetrating the jungle and drilling these wells indicated the necessity for the enlistment of an organization of wide experience and very substantial resources to develop commercial production. The Pittsburgh interests sought the aid of International Petroleum Company, Ltd., whose notable success in Peru logically attracted their attention. Through Imperial Oil Company, Ltd., International was affiliated with the Standard Oil Company of New Jersey.

Large scale development work was undertaken on the De Mares concession about 1920. The company had first to face a number of physical difficulties that might have seemed insurmountable a few years earlier. The only avenue of transportation reaching Barranca Bermeja was the Magdalena but the shifting course of the river, the numerous sand bars and snags and the swift current made it difficult to carry the heavy drilling equipment to the field. It was necessary to construct specially-designed tow boats and barges as well as a railroad from Barrance Bermeja to El Centro.

The greatest precautions were necessary to avoid the incidence of disease that wrecked the first efforts to construct the Panama Canal. Moreover, there was no center of population close by and labor had to be recruited from up and down the valley for many miles, suitable housing had to be arranged and supplies secured to feed at least 5,000 workmen and 500 staff members at the peak of construction.

Medical and sanitary work, housing, supplies, road and railroad building, the design and building of a river fleet were of course, incidental to the main work of drilling up the field, laying gathering lines, constructing tankage, machine shops and a power station. Well over $50,000,000 were invested before a single barrel of oil reached seaboard.

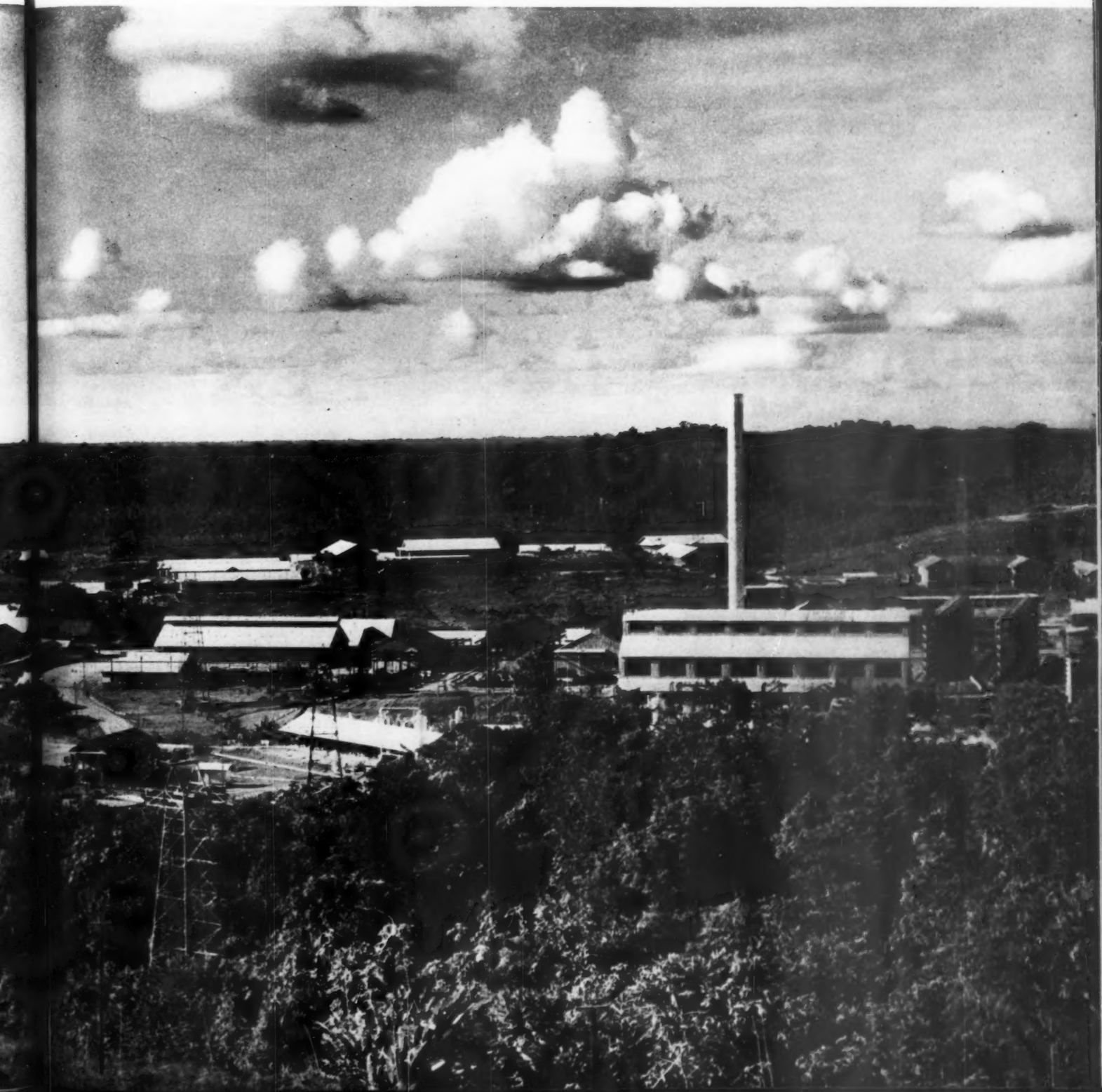
Finally there emerged in the jungle after much patient effort and heavy expenditure a community complete with schools, hospitals, clubs, comfortable residences for

JUNGLE BUILT ON OIL

married and single staff, modernized quarters and messes for workmen, a golf course and recreation grounds for all. The camp was served by a modern water treating and sedimentation plant, ice and refrigerator plant and a large commissary supplying the wants of workmen and employees virtually at cost. Due to the distance from manufacturing centers very complete machine and blacksmith's shops were necessary. Over 500 kilometers of roads had to be built. Each well requires a specially built road involving excavation and grading and is usually completed several months in advance of moving-in with drilling equipment.

Over these roads travel the 300 trucks and automobiles of Tropical's fleet. These vehicles operate only on the concession for while there is now a road to Barranca Bermeja, the usual method of travel from El Centro to the river port is over the 30 kilometers of narrow gauge railroad built by the company.

View of part of El Centro camp; the large building with smoke stack is the power house.



Above—Drilling well on the west flank of La Cira structure. Right—Gun perforating equipment mounted on an old but still serviceable truck

a depth around 4,000 ft. On the Infantas anticline the levels of the B and C sands are somewhat more shallow.

Well spacing in the field varies depending on the particular zone characteristics, depth and pressure conditions. On the Infantas anticline, which was developed in advance of repressuring or pressure maintenance operations, the conventional 10 acre spacing prevails. Drilling of the C-zone at LaCira commenced with 8.56 acres per well on a triangular pattern but with the introduction of a pressure maintenance program about 1930 the spacing was altered to 17 acres per well. Spacing in the B-zone

In its present stage of development the field consists of two anticlinal structures comprising an aggregate of approximately 12,000 producing acres.

The early wells were drilled with cable tools and this system of drilling was used with more or less indifferent success during the first few years of development. The formations consisting mostly of unconsolidated sands and shales do not favor the cable tool method. About 1925 rotary rigs were introduced in the field and rapidly proved their superiority over cable tools. For the past twelve years rotaries have been used exclusively.

During 1938 six strings were used in the drilling program averaging 10 completions per month, principally on the LaCira structure, Infantas being practically drilled up. The crude has an average gravity of 25 deg. A.P.I.

Steam driven rigs are used as there is an abundant supply of natural gas available. Practically all of the footage drilled is made with drag bits, either the two-way or four-way type. Draw-works units which were purchased prior to the unitization scheme adopted by manufacturers in the north have been unitized in the local shops.

The casing program has been varied from time to time although the general trend has been toward the use of smaller diameter pipe. At present the general practice, after cementing 13⅜ in. surface pipe, is to carry an open hole to the top of the producing sand where either an 8⅝ in. or 6⅝ in. oil string is set and cemented. In completion a 5¾ in. or 4½ in. slotted liner is set opposite the producing section. In some cases, however, a 6⅝ in. combination string is run to bottom and cemented through perforations just above the producing sand.

Gun-perforating has been used for the past two or three years to a considerable advantage. This method was primarily used on old wells in which the upper sands had been cased off when the wells were originally completed in the deeper zones. Where pressure maintenance is being carried on in the lower zone the latter was plugged off prior to perforating, but where this condition is not a factor the two zones are produced simultaneously. During the past year the gun-perforator has proved a valuable adjunct in the completion of edge wells where water may be present.

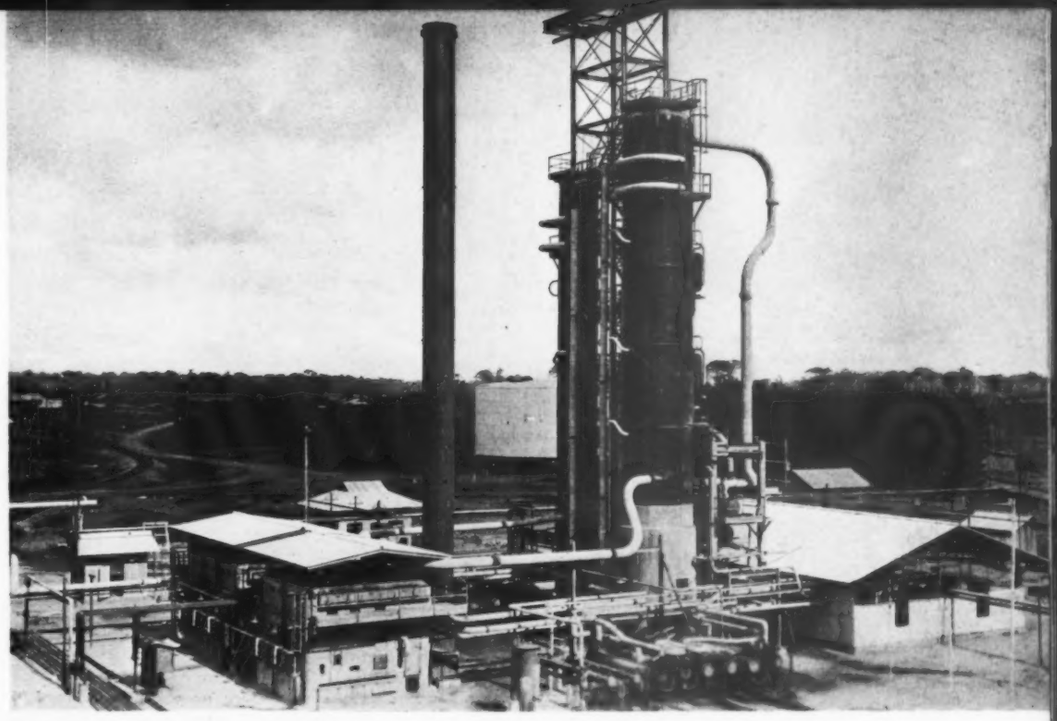
Three distinct producing zones are present on the LaCira structure, while at Infantas there are only two. These zones are designated as A, B, and C in the order of depth, with the C-zone being the most important both with respect to area as well as yield.

At LaCira near the crest of the structure the respective levels of the A, B, and C zones are roughly 1,000, 1,500, and 2,000 ft. These horizons gradually increase in depth toward the flanks of the structure and on the outer edge the C-zone is encountered at

carried a somewhat higher density, although the pattern is not uniform as many of the older C-zone wells have been converted to the intermediate sand producers by means of gun-perforating. Final development plans for the A-zone have not been definitely formulated, although from the sand thickness and the characteristics of the crude it is probable that a spacing between five and ten acres will be used.

To date approximately 1,000 wells have been drilled in the Infantas and LaCira structures. Of these 835 were producing in 1938. Natural flow, gas lift and pumping are used to raise the oil with pumping predominating to the extent of over 80 percent of the total production. Natural flow accounts for less than eight percent of the production.

With the exception of two central pumping powers the wells are equipped with individual pumping units. The extremely broken terrain and the heavy undergrowth are not conducive to central power pumping. Due to the wide range in well depth and load conditions, pumping equipment of various capacities is operated in the field.



Two-stage distillation unit, 7.000 bbl. capacity located at Barranca Bermeja to supply a large part of Colombia's domestic consumption.

A distinctive feature is the extensive application of electric power for practically all plant and field operations outside of drilling. The generating plant of 7,000 K.W. capacity is located at El Centro, and primary current distribution within a radius of three kilometers is at 2,300 volts, while at greater distances 13,200 volts are used. Secondary current distribution throughout the field is at 440 volts from field transformer stations which are located so as to provide service areas of approximately one square kilometer per station. Capacities of these stations range from 50 K.V.A. to 225 K.V.A. (all three phase) depending upon the number of wells and oil gathering stations situated in the particular service area. While electrification has been carried out on a large scale, the most important as well as the most interesting application has been to well pumping equipment.

When the first well pumping motors were obtained for the field the type of pumping equipment on hand was the "standard front," an adaptation of the cable tool drilling rigs. As this equipment was used for both pumping and servicing, dual rated motors of 15/35 h.p. were installed. Later, as manufacturers of pumping units improved their design, more compact and more efficient pumping equipment was installed. Also portable hoists for well servicing were placed in use.

A power survey made about this time indicated that the average load factor in the field was less than 50 percent. From this fact the obvious conclusion was drawn that in order to realize the greatest overall efficiency, driving motors must be selected as to type and size for the particular load condition at each well. With the idea in view of effecting the greatest possible economy in power consumption, a regular schedule for taking periodical power tests on the several hundred pumping installations was started a few years ago. The outcome of this program has been an almost constant interchange of motors to accommodate changing conditions. In one instance the correct motor application on about 350 pumping wells resulted in reducing the power consumption nearly 4 K.W. per well. At the present time motor sizes range from one horse power up to 15 h.p.

In conjunction with the periodical power tests, the volumetric or fluid efficiency of the pumping equipment is ascertained. Whenever this factor is found to be in need of correction, the necessary adjustments in speed, rod travel or working barrel size is effected. In many cases pumping units are replaced with those of smaller capacity and the larger ones moved to deeper and heavier wells. Continuous pumping is favored over intermittent pumping, and on very small wells speeds as low as two strokes per minute are used. The primary purpose, of course, for the constant check-up on all pumping well operations is to keep lifting and maintenance costs down to a minimum.

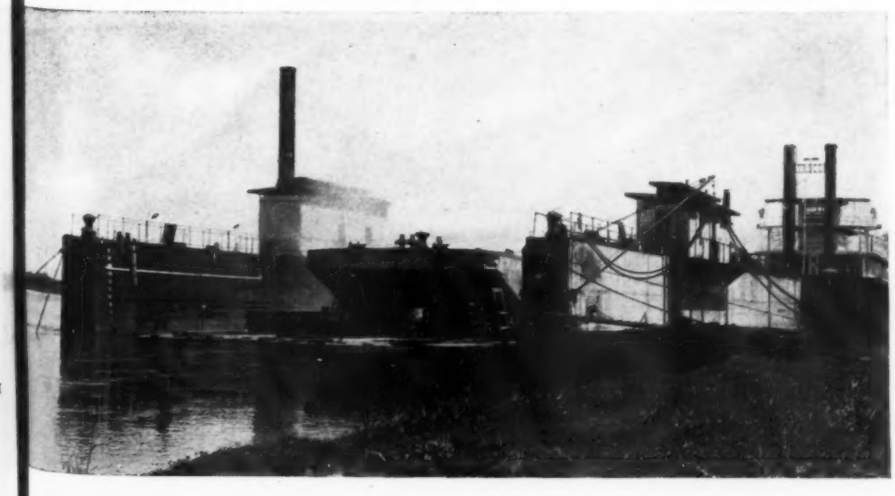
As already stated, well servicing equipment is now all of the portable type and both electric and gasoline engine driven hoists are used. The latter are employed chiefly in clean-out work which is performed mainly with hydrostatic boilers and perforation cleaners. The amount of clean-out work done is probably more than in most fields but here again it is believed that by keeping the wells as free as possible of loose sand the expense incurred will be more than offset by lower maintenance costs on pumping equipment.

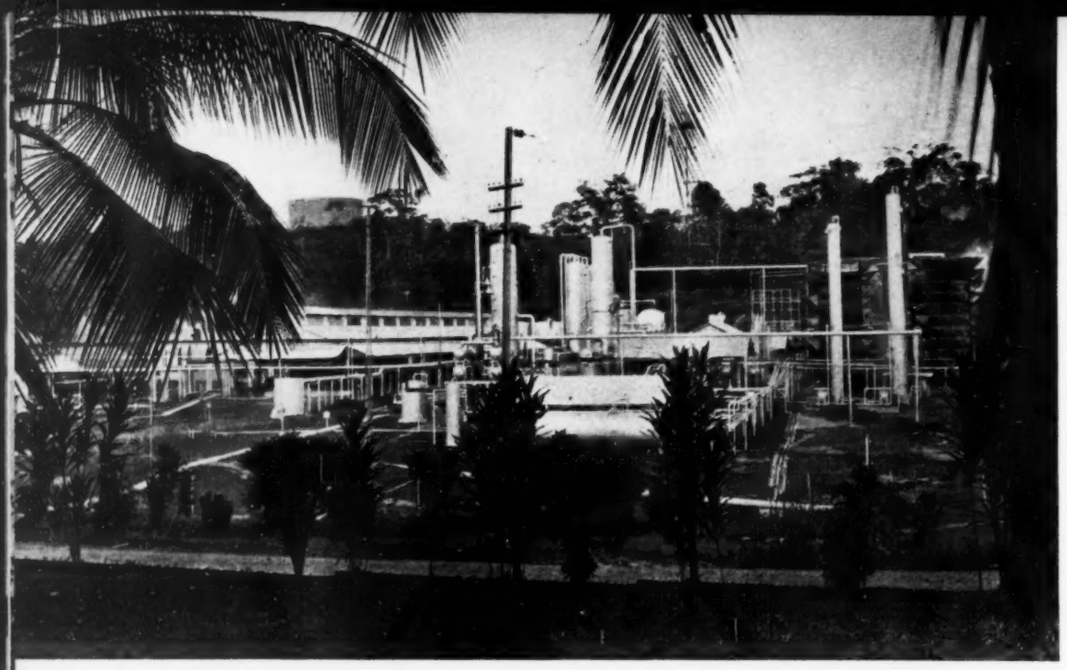
Edge water is encountered on the lower flanks of both structures but up to the present time this condition is far less pronounced at La Cira where pressures are higher than on the Infantas anticline.

All the emulsified oil is delivered to a central dehydration plant for treating. Both heat and chemical, as well as excelsior tanks, are employed in the treating process. The emulsion from the field is first received in a 55,000 bbl. tank from which it gravitates through a battery of return tubular boilers used as oil heaters. The chemical is introduced before the emulsion stream enters the boilers where it is heated to a temperature of 160 deg. F. After leaving the heaters the water-oil mixture passes through a gas scrubber where any vapors leaving the crude are separated under a slight vacuum, and the gasoline recovered at the absorption plant. Likewise all the excelsior and settling tanks are of the gas tight type equipped with vapor recovery lines. The treated oil after settling leaves the dehydration plant containing less than 0.2 percent water.

Gas conservation has been practiced by the Tropical Oil Company since the beginning of producing operations on the concession. In the early life of the field, reservoir energy was conserved by maintaining back pressure on all flowing wells. New wells were completed with tubing strings, and packers which were set just above the producing zone.

Marine department dry dock where the river fleet of Tropical Oil Company is maintained for efficient service.





El Centro natural gasoline plant photographed from the garden in front of the general offices.

The second stage in the conservation program was to restrict production of gas by shutting-in completely high gas-oil ratio on those wells situated on the crest of the structures. Later, as the producing areas were extended, reservoir pressures were augmented by gas injection. Gas return was started about 1930 and during the past six years a daily input to the producing sands of between 17,000,000 and 25,000,000 cu. ft. has been maintained.

Input pressures range from 300 to 800 lbs. and input wells in the La Cira field are all situated on the structural highs. This practice has been somewhat modified on the Infantas anticline due to peculiarities of structure, mainly transverse faulting. Due to sand and oil characteristics, the C-zone formation lends itself best to repressuring.

There are five natural gasoline plants operating in the field with an aggregate compressor capacity of 15,000 h.p. Fifty-one units are used in low pressure service while twenty-two are high pressure units used in repressuring work. Gas from the separator stations enters the plants at 10 to 12 in. vacuum and is compressed in two stages to 90 or 100 lbs. At this pressure it is passed through mineral seal absorbers for gasoline extraction. The residue gas, after fuel requirements for the field and the refinery have been supplied, is recompressed in two more stages and finally returned to the producing sands.

The distillation of the mineral seal oil is carried out at the main or central plant and likewise the stabilization of the raw product. At the El Centro plant there are two distillation units, one for taking care of the absorption oil at the local plant and the other from the four outlying plants. A portion of the finished natural gasoline is transported by means of a pipeline to the refinery at Barranca-Bermeja where it is blended with straight run gasoline to supply market requirements within the country. The balance of the field product is mixed with the crude delivered to the Andian Pipe Line Company which transports the oil to tidewater for export.

Various other operations are carried on in connection with the El Centro gasoline plant. One is an oxygen manufacturing plant which supplies the requirements of this product to the shops in the field and at the refinery. Another is the recovery from the stabilizer of propane gas which is employed for cutting purposes. This gas is piped directly from the stabilizer to the welding shop where it is delivered through a regulator to the cutting torches. A bottling plant for bottling acetylene gas supplied by carbide generators is also installed here.

P. F. Shannon, resident manager, is in charge of operations at El Centro.

Production from the field is run to the refinery where it is processed and products distributed throughout the Republic. No refined products except fuel oil are exported. By far the greater part of the crude production goes to the National Andian pipeline which transports it to Mamonal on the Caribbean whence it is taken by tanker to Aruba to be refined and distributed in Europe, and to the Halifax and East Montreal Refinery of the Imperial Oil Limited for distribution in Canada.

The refinery located at Barranca Bermeja, 18 miles from El Centro, is a complete installation consisting of a crude still battery, a two stage distillation unit, a phenol plant and an asphalt plant as well as plants for making lubricating oils and greases, drums and tins, together with loading facilities and tankage.

The continuous crude battery consists of four shell stills, No. 1 being equipped with bubble tower, partial condensers and heat exchangers while Nos. 2 and 3 are equipped with bubble tower and partial condensers.

Crude is picked up from storage by charging pump, and after passing through partial condensers and heat exchangers, is charged to the bubble tower of No. 1 still. Bottoms from No. 1 still are then fed to Nos. 2 and 3 stills by steam lift. Nos. 2 and 3 stills are so hooked up that if the charging rate on No. 1 exceeds 4,500 bbl. per day, the charge to these stills can be split. Lime is fed with the crude charge to No. 1 still to reduce corrosion. The overhead products taken off this battery are naphtha, kerosene and gas oil. Nos. 2, 3 and 4 stills are hooked up so that when they are not in service in the crude battery, they can be used to manufacture liquid asphalt.

Crude oil from storage is also charged to

(Continued on page 79)

El Centro power plant; practically all operations except drilling are electrically powered.

the Foster-Wheeler combination two stage distillation unit through heat exchangers, crude being preheated to a temperature of approximately 350 deg. F. before entering the tube still. The coil discharge is flashed into the atmospheric fractionating tower. Products taken from this tower are: light naphtha, overhead; heavy naphtha, top side stream; kerosene, center side stream; and gas oil, bottom side stream. These streams are governed by control valves at the point where they are taken from the tower, and run by gravity through coolers and thence to storage. Bottoms from this tower are then picked up and charged to the vacuum coil, then flashed into the vacuum tower where gas oil is taken off as an overhead stream, the residuum taken from the bottom of the tower being used as a base stock for the production of asphalt. When operating this unit on low cold test crude for the production of lubricating oils, three side streams are taken off the vacuum tower; top being light lube distillate; center, heavy lube distillate, and the lower side stream being cylinder stock. To reduce corrosion in this unit, five degree Bé lye is injected into the flash zone and condensers on the atmospheric side, and into the coil outlet on the vacuum side.

The phenol plant consists of a three foot packed treating tower together with heating coil, accumulator, bubble tower, condensers, and tankage for finished and unfinished stocks.

Raw lubricating distillates produced at the Foster-Wheeler unit are each in turn pumped to untreated storage tankage. The raw distillate is then pumped through a steam jacketed heater and thence to the bottom of the counter current treating tower. Similarly, the phenol is heated by pumping through a steam jacketed heater and thence to the top of this tower. Treated oil containing a small percentage of phenol is drawn off the top of this tower. Spent phenol and extract is drawn off the bottom of the tower and is then charged to the accumulator and circulated through the coil and thence into the flash zone of the bubble tower. The phenol driven off is condensed on the top of the bubble tower and then taken to storage, the oil returning from the bottom of the tower to the accumulator. As the liquid level in the accumulator lowers due to distillation of phenol, fresh stock is charged to the accumulator. When the majority of the phenol has been removed, the tower is then placed under reduced pressure for complete removal of the solvent. When the charge in the accumulator has been completely dephenolized, it is pumped to extract storage. In a similar manner, raffinate is charged to the accumulator, and thence to the coil for removal of phenol.

This raffinate is transferred and charged to a rerun flash coil where a heart cut is taken to the viscosity and color specifications of the finished grade of lubricating oil.

Asphalt base stock is taken either directly from the bottom of the vacuum tower on the Foster-Wheeler unit and charged to a 10 ft. by 30 ft. vertical oxidizer, or taken from storage, heated in one of the shell stills in the crude battery and charged directly to this oxidizer. This unit is provided with a small fire box that is gas fired for maintaining temperature. Air for oxidation is provided by a low pressure air compressor installed in the pumphouse. Oxidation is carried out until the batch is brought to specifications required, when it is picked up by a tar pump and discharged through a steam tracered insulated line to the asphalt filling building.

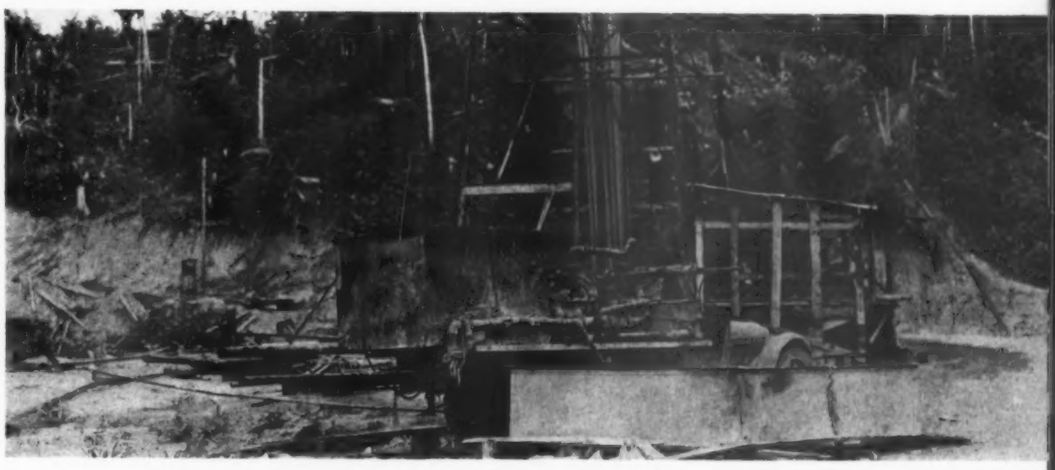
In general if charging capacity of 7,500 bbl. per day or less is required the two stage distillation unit only is used, the 4,000 bbl. per day shell still capacity being held in reserve. In order to continue its policy of supplying fuels having the highest octane and quality a demand for which is now foreseen, it seems likely that Tropical may install a cracking unit at Barranca Bermeja before very long.

Refining operations are under the direction of W. E. Longworthy.

Within the past few months there has been completed between Barranca Bermeja and Bogota a road but as yet this is hardly suitable for tank trucks or heavy traffic so the river still remains the principal avenue for distribution of petroleum products. The Troco refinery supplies the entire country with the exception of a small gallonage handled by Shell at Barranquilla which is imported from Curacao and a few Socony pumps found in Cucuta.

Bogota, the capital, represents the largest market and to reach its 8,400 ft. elevation, petroleum products must be shipped up the Magdalena to La Dorada, there transshipped by rail to Bogota. Medellin and Cali represent other important centers reached by combinations of river, rail and road transport. T. W. King at Cartagena is sales manager.

As early as 1922 a fleet of four stern wheel steamers with eight barges was placed in service. As the river current reaches a velocity of seven miles per hour in places, considerable power is required so that two of the steamers had 707 h.p. and two had 250 h.p. Six of the barges were 100 ft. and two were 50 ft. long. There are now nine steamers and 40 barges.



Well cementing outfit in operation at El Centro.

Horsepower on later additions to the fleet amounts to 1320 h.p. During 1938, 2,463,110 bbl. of bulk products were moved on the river at the rate of approximately 15,000 bbl. per trip. The development by Tropical of the system of pushing barges ahead of the steamers is the only thing that makes it possible to move such quantities of cargo with the present efficient fleet. To appreciate the difficulties of maintaining adequate distribution relying primarily upon the river, it should be noted that the average draft of water in the river for 12 months is four feet. The company maintains their own dry docks and designed and developed all their own fleet with the exception of the four original steamers. The personnel is entirely Colombian. Operations are directed in Colombia by G. H. Birchall.

The foresight and persistence of the Colombian and North American groups connected with the development of the De Mares concession has been rewarded by building this single concession to a point where Colombia is the world's ninth largest oil producer, and all her domestic requirements are supplied at about the lowest cost in South America.

Vital Link Between Oil Field and World Market Represented by ANDIAN PIPELINE

Three Hundred and Thirty-Five Mile Pipeline, Major Factor in Colombian Economy, Has Transported 206,000,000 Bbl. With Utmost Efficiency Under Direction of Captain J. W. Flanagan.

FOLLOWING the Andian pipeline through the jungles of Colombia in a launch on the Magdalena River, walking through the spotless pump stations and realizing that over 50,000 bbl. of El Centro crude daily flow through the line it is difficult to picture the negotiation, organization work, preliminary surveys and actual construction necessary to the present smooth functioning of this great service. For all its 335 miles no oil is in sight: pump stations are spotless within and beautiful in their setting of tropical gardens: unhurried but competent Colombian and North American workmen move about the stations. Occasionally the company's hydroplane lights on the river carrying one of the two doctors constantly patrolling the line to maintain a rigid standard of health: or one of the big stern-wheel river boats reminiscent of the Mississippi in the last century glides swiftly down stream or bucks the seven mile an hour current upstream with automobiles, cattle and equipment for the interior. The whole impression is one of quiet unhurried efficiency in the performance of a tremendously important job.

Captain J. W. Flanagan

One concludes very soon that this industrial efficiency in the steaming jungle valley must be the expression of an extraordinary character. One's conclusion is justified by the repetition of a name that is apparently as familiar in forgotton fincas along the river as it is in Bogota, Toronto, or New York.

In 1919 Captain J. W. Flanagan arrived in Bogota after a tedious 15 day trip up the Magdalena by river boat and a mule back journey to the eight thousand foot elevation of the Bogota savannah. He had arrived to start negotiations with the Colombian government for the construction and operation of a pipeline from the jungle field of El Centro to the ancient port of Cartagena. Down in the valley surveys were being carried out under his direction while in the beautiful capital, Captain Flanagan met almost daily with government representatives. Deliberately, these able men considered every aspect of the proposed project. Finally in October 1923 the contract was executed under which the line was built and is operating today. Studies and surveys in the valley were pushed forward with renewed vigor and in January 1925 the initial pipe order was placed.

Captain Flanagan was acting on behalf of the Andian National Corporation, Ltd., organized in Canada with a dominion charter in 1919. It derived its resources from the sale of shares to Canadian, British, United States, and Colombian interests. Captain Flanagan, as president, handled the negotiations, actively supervised the original construction and has directed the policy of the company from its inception to the present day. When he is not flying to Bogota, working in New York or studying operating reports in Cartagena, the Captain is to be found atop the tallest building in the British Empire in Toronto directing the policies of his company and planning his further industrial and philanthropic activities covering two continents.

Left—The Andian hospital at Mamonal where employees and the public receive excellent medical attention. Above—The Andian building in Cartagena which may also be seen in the larger Scadta airview of the city and bay, in the right foreground.

Operations of the company are in such competent hands as those of L. P. Maier, vice president who as engineer participated in the surveys and construction, and H. A. Burgon, secretary treasurer. In Bogota the company is ably represented by R. I. Dodson and his assistant, H. B. Richardson and is managed from Cartagena by J. K. Rose and P. C. Schiffers. The pipeline superintendent is E. L. Sturm and P. C. Klintman is in charge of station operation.

Construction of the line was accomplished in the remarkably short time of 11 months from laying of the first joint on April 4, 1925, to completion on March 6, 1926. This was six months earlier than even the most optimistic estimates. It included the construction of 10 pump stations, laying 335 miles of 10 in. line and the installation of a metallic circuit telephone system paralleling the pipeline.

Government officials made their inspection and gave the line official authorization on May 27th, 1926. The transportation of oil was immediately inaugurated. This original construction provided a carrying capacity of about 30,000 bbl. of crude oil per day. Including station pumping equipment, 60,000 tons of material went into the construction of the line, all of which was handled through the Port of Cartagena, thence by rail to Calamar, where it was loaded on river steamers for distribution at various points along the pipeline. During the construction peak there were about 3,000 Colombians and 250 North Americans employed. The difficulties encountered both in the original surveys and construction can be readily appreciated, as no roads existed, the line itself being located mainly through trackless jungle. Transportation difficulties were enormous, and labor at that time, while extremely willing, was entirely inexperienced. Health conditions might well have been bad, especially in the wet seasons, as the annual rainfall is approximately 120 in. per year.

During the construction period with Captain Flanagan actively in charge, engineers and workmen were housed in large screened houseboats mounted on steel barges which could be moved along the river as the work progressed. Despite the dampness and heat of the valley the efforts to maintain the health of the workmen were rewarded by the fact that not a single life was lost as a result of malaria or dysentery. The Medical Dept. was supervised by Dr. A. W. Schoenleber of New York.

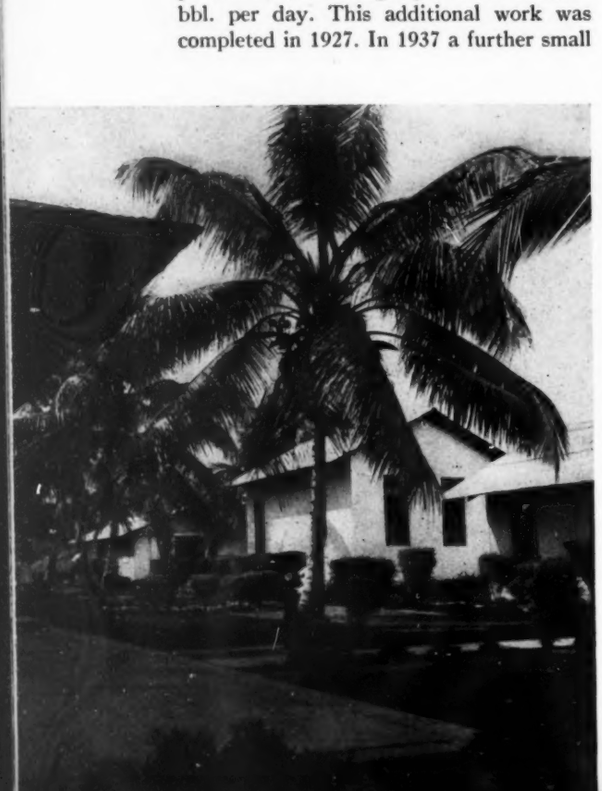
Great stern wheel river steamers of remarkably shallow draft conveyed thousands of tons of equipment to points on the

river bank and from these unloading points material was distributed up and down the river on truss-wheel carriers over crude roads hacked through the jungle. Some mechanical ditchers were used but a large part of this work had to be done by hand due to the swampy conditions and dense jungle growth. At that time welding had not reached its present highly efficient point, so screwed joints were used. All subsequent repairs have, however, been welded and a certain amount of this work is carried out every year due to the highly corrosive nature of the soil through which the line passes. Originally the line was treated with asphaltic enamel but frequent retreatment has been necessary.

Interior of the Andian pump station at Plato. Left—Employees' residence overlooking the river at Calamar.

Almost immediately upon completion of the first line, it was decided that additional carrying capacity was required, and two hundred and eighty miles of 10 in. loops were laid, increasing the potential throughput from 30,000 to slightly more than 50,000 bbl. per day. This additional work was completed in 1927. In 1937 a further small increase was needed, which was secured by the construction of about 20 miles of 12 in. loops, increasing the throughput for the type of oil now being handled to approximately 52,500 bbl. per day.

Sixteen miles inland from Barranca Bermeja on the river is the El Centro field producing from two important structures—the Infantas and La Cira. Field oil is run to storage in three 80,000 bbl. and three 55,000 bbl. tanks and thence to the 10 in. line originally laid from the field to the river port. Subsequently a four mile 10 in. loop was installed increasing the capacity of the line. Four 260 h.p. De La Vergne Diesel engines, direct connected to four Prescott duplex pumps start the crude on its way to tidewater. The next pump station is at Galan a few miles down river from Barranca Bermeja. This station is equipped with three 500 h.p. Diesels and three Prescott triplex pumps 6¼ in. bore by 24 in. stroke. Two 60,000 bbl. tanks are available here. The line is looped the entire distance of 45 miles to the next station at Chingale making parallel 10 in. lines. It crosses the Rio Sogamosso within a few miles of the Galan station.



Picturesque grounds around the Chingale station.

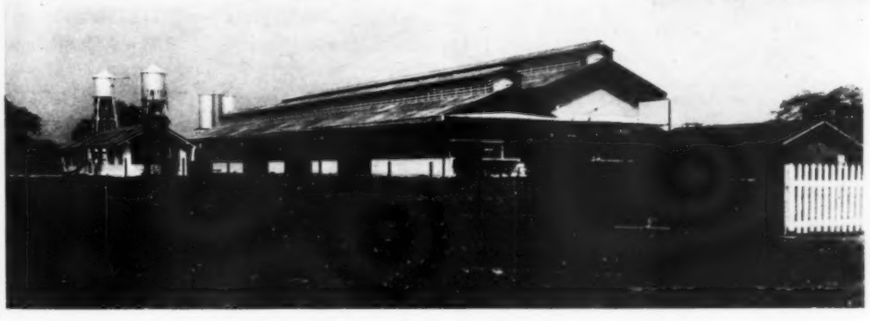
Chingale is the first typical jungle pump station having two 500 h.p. Diesels direct connected to two Prescott triplex pumps having 6½ in. bore by 24 in. stroke. There are an additional two 200 h.p. De La Vergne Diesels direct connected to two National Transit duplex pumps with 5½ in. bore and 24 in. stroke. Both the 200 h.p. Diesels or either of the 500 h.p. Diesels can be cut out any time for repairs or reconditioning. The engines take fuel direct from the line. Two 30,000 bbl. tanks furnish storage capacity here as at all river pump stations. The station is equipped with generators, ice plant and domestic water systems providing for chlorination of the water. There are separate office buildings, a well stocked warehouse, separate residences for families and bachelor quarters as well as mess halls. All buildings are double screened and the grounds are planted with tropical trees and foliage, lawns between the buildings being beautifully kept up. First aid equipment is available and in case of serious sickness the patient can be transported to the well equipped hospital at Mamonal in a few hours by company plane.

Chingale station is described in detail because the same equipment and facilities are maintained at all the other stations down the line until one reaches Barranca Nueva station where the line leaves the river and starts across country to Cartagena and Mamonal.

Proceeding downstream (north) from Chingale the line is some distance in from the river and for three and a half miles consists of 10 in. single line where crude is traveling under 500 to 600 lbs. pressure. The first loop of 12 in. occurs at the 3½ mile point and continues for almost three miles further. From there two 10 in. lines carry the oil under reduced pressure to the Puerto Mosquito station located a few miles in from the river. The distance from

Exterior of the Barranca Nueva station, first pump station encountered going up river.

Right—Loading dock at Mamonal through which 17,000,000 bbl. of Colombian oil passed in 1938. Below—Mamonal terminal station where loading pumps are located.



Chingale to Mosquito is 35 miles and the line crosses the Rio Liebrya.

A similar system of loops carries the line 38 miles further down stream to Costilla although on this stretch the line crosses no major river. Some six miles above Costilla the Andian line is crossed by the right of way of the South American Gulf Oil Company's pipeline from Petrolea to Coveñas.

Following the bend in the Magdalena the pipeline, looped as outlined above, crosses the Rio Cesar near the town of El Banco. Here the Magdalena splits to form the Island of Mompas and a few miles down the east branch is located the Los Negritos pump station. All the major river traffic now follows the west branch of the river but boats and supplies can be sent down the east branch when necessary.

Forty miles further down the east branch is located the Santa Ana station. Another forty-one miles brings one to the Plato station. Three and a half miles below Plato the line crosses the Magdalena and reaches the Barranca Nueva station located within a few miles of Calamar. The Barranca Nueva station carries the same equipment as that at Galan and marks the point where the line leaves the river and starts due west toward Mamonal in a straight line. Two parallel lines one 10 in. and one 12 in. leave the station but a mile and a half away these become two 10 in. lines until within a mile of the Mamonal station where a single 10 in. line carries the oil to the last pump station which exerts sufficient negative pressure to maintain the flow.

Mamonal is equipped with a tank farm comprising fifteen 80,000 bbl. tanks. There are four 260 h.p. De La Vergne Diesels direct connected to 11½ in. by 24 in. Prescott loading pumps. A berth is provided for mooring and loading tankers on Cartagena Bay. Oil can be delivered at an average rate of 9,000 to 10,000 bbl. per hour.

To January 1, 1939, some 206,335,858 bbl. of crude have passed through the line since its inception.

In addition to the pipeline and pump stations, the Andian National maintains a warehouse and depot at Calamar carrying an inventory valued at well over $500,000. Cartagena headquarters are established in a modern seven-story office building constructed by the company. Andian has assisted in various construction projects in Cartagena and elsewhere in Colombia, the most recent being the partial financing of the piers at Cartagena which are among the most modern in South America, and the Cartagena waterworks. The company maintains an extremely well equipped and beautifully designed hospital with 60 beds and a large medical and nursing staff. While primarily for the treatment of employees the hospital is also open to the public and complicated cases have travelled many miles to receive treatment in a hospital which has an exceptional reputation.

That the original negotiations resulted in a contract that is still fully acceptable to both parties, that the line was constructed without loss of life in half the time estimated, that it functions today without undue mechanical or social friction reflects the ability, knowledge and experience that Captain Flanagan brought to the planning and construction of this line. In recognition of his work he has been decorated by the national government with the cross of Boyacá, in the official and military class, an honor bestowed on only two individuals outside of Colombia. Captain Flanagan also was made an honorary citizen of the city of Cartagena.

BARCO OIL To Flow in International Trade Soon

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Colombia Will Assume More Significant Position in World Oil Trade When Petrolea-Covenas Line Carries High-Grade Crude to World Markets. Hinterland Being Opened up by 260 Mile Road Paralleling Pipeline.

THE story of the now famous Barco concession started in 1900 in the virgin jungle forty miles from Cucuta where two men had separated slightly from a party of four that composed an expedition to a point near the Sardinata River. The two men were Miguel known as "El Paton" and Juan. They were plotting the death of their companions and guides, Ramon Leandro Penaranda and his son for the purpose of laying claim to an oil seepage toward which the party directed its journey.

Five years earlier Ramon Leandro Penaranda traveling in the Catatumbo region over the area now known as the Barco concession happened upon a hidden oil seepage. Ramon marked the spot well, took a sample of the oil and returned to his native city of Cucuta. Confiding in his friends some years later he aroused the interest of two unsavory characters who agreed to accompany him to the seepage.

When the party arrived on the spot Juan and El Paton seized the unsuspecting guide, bound him and his son and left them some distance from the oil seep. Although night would soon overtake them the conspirators set out on the return journey to Cucuta. Within a few hours they were hopelessly lost in the jungle and counted themselves lucky to find Penaranda and his son still alive when they dragged themselves back to the spot where they had left their victims. Throwing themselves on his mercy they implored Ramon to guide them out of the forest.

Sometime later a better equipped and more law abiding expedition again visited the seepage under the leadership of General Virgilio Barco, a large land owner of the Department of Norte de Santander. From the moment Barco set eyes on the seepage until his death, it became the central object of his life's work. In 1905 he obtained a concession for the production of oil in an area of 700,000 hectares.

Work must have progressed satisfactorily for the following telegram is preserved in the files of the Petroleum Department at Bogota:

"Cucuta, 11th September, 1906: To General Rafael Reyes, President of the Republic, Bogota. Roads are finished as

Left—Petrolea camp on the Barco concession, seen from the air. Below—Petrolea No. 29 photographed just after it came in for 1,600 bbl. per day from 510 ft.

© W.P. Staff

far as Reyes Bridge over the Sardinata River. The crude oil fountains discovered can yield over 1,000,000 gallons daily. I solicit from the Ministry of Public Works a permit to erect temporarily a refinery in this city in order to utilize some of the wasted wealth until I put up buildings, etc., in accordance with contract. I beg of Your Excellency to second my petition.

Your servant,
Virgilio Barco"

The petition was granted shortly afterwards to establish "the machines, apparatii and other appurtenances for the refining of crude oil." The refinery still exists today and is illustrated in an accompanying picture. Charging stock was obtained by dipping oil from the seepage in buckets: small quantities of illuminating oil were distributed locally.

Further development by General Barco was blocked by lack of funds and the concession was transferred to North American interests, cancelled by the Colombian government, and finally reestablished under a new agreement known as the Chaux-Folsom contract. The concession was then held by Gulf interests through the Colombian Petroleum Company and the South American Gulf Oil Company. Gulf's interest in these two companies and in the concession was subsequently transferred to Socony-Vacuum Oil Company, Inc., and The Texas Company who each hold an equal interest. This transfer occurred in 1936 which, in a sense, marks the beginning of active development of the property.

General Barco had died before reestablishment of the concession in 1931 but had bequeathed his 15 percent royalty interest to a company having 100 shares or units of participation. Some of these have been sold; others remain in the Barco family,

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Above—Looking westward down the Petroleaway from the West Barco Covenas pipeline right of Ridge. Left—One of the towns in the Eastern Cordillera near which the pipeline passes. Below—Pipe wrapping machine in action between the Magdalena and Covenas; airview below shows nature of ground over which work is being carried on west of the river.

Puerto Reyes on the Sardinata through which most of the heavy equipment for Petrolea passes.

one member of which now resides in Cucuta and is active in business circles there.

From a total area of 700,000 hectares the company is to select 200,000 hectares for exploitation and since the new interests have taken over, work has progressed rapidly.

Five zones indicated on the accompanying map inset, in the southern part of the concession, have already been tentatively selected and a total of 49 wells drilled to the end of 1938. Of these only 11 had been drilled prior to 1936 when Texas and Socony interests started work. The potential is estimated as 68,194 bbl. per day; but this figure is subject to considerable modification. Due to the lack of outlet and limited storage capacity potential has been figured on very short runs of sometimes as little as one hour. The oil is obtained from shallow wells under considerable pressure and is of high gravity ranging from 36.7 to 45.6 deg. A.P.I.

Two main fields are now under development and a number of wildcats have been drilled. The first well on the concession was drilled in the Rio de Oro field on the river of that name at the northern extremity of the concession. Subsequent drilling at Rio de Oro included eight additional wells of which four came in for production with a potential estimated at 8,618 bbl. per day as of the first of this year. One string is currently operating in this field and a second may soon be added. Depths range from 1,170 ft. for Rio de Oro No. 8 to 1,615 for No. 4.

The second and at present most important field is Petrolea in the southeastern part of the concession. Some 39 wells have been drilled here of which 28 are producers with a potential estimated at 59,576 bbl. per day. Earlier wells ranged in depth from 1,190 to 3,008 ft. but during 1938 no well has exceeded 948 ft. and the average depth has been 620 ft. During 1938 four strings of tools were running but plans called for several additional rigs in operation during 1939.

While the wells are shallow and the drilling not especially difficult at Petrolea, pressure conditions are tricky and blow out preventers are used on all wells. There are at least four production zones in the field, the first between 200 and 300 ft. Until 1938 medium weight steam rotary rigs have been used but the use of some Diesel powered drilling outfits was begun during that year.

Seven wildcats have been drilled south of Petrolea North Dome, of which six are dry holes, the last being Leoncita No. 1 abandoned at 3,045 ft. in May 1938. Early this year Carbonera No. 1 was drilling at 2,130 ft. while another location was being prepared further south.

From Cucuta, the camp at Petrolea is reached by taking the national railroad toward Encontrados, Venezuela, following the company's spur from a point on the railroad 54 kilometers out of Cucuta to Pto. Leon, crossing the Rio Zuila by boat and traveling down the recently completed company road to Empalme. From here all travel on the concession is by narrow gauge railroad. Heavy equipment and supplies are brought in through Maracaibo, Venezuela, up the Catatumbo, Rio Tarra and the Sardinata to Puerto Reyes a few miles from the main camp. There is also an aeroplane landing field between Puerto Reyes and Petrolea, recently completed. To reach the Rio de Oro field it is necessary to go by rail to Encontrados and up the Catatumbo and Rio de Oro to the camp.

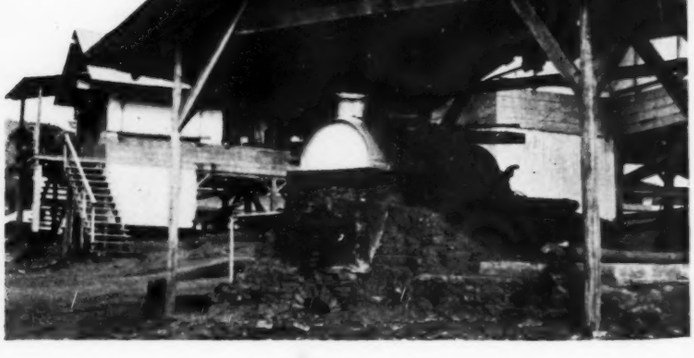
Some 3,000 men are employed on the concession, hospitals and medical staff have been organized at both camps and additional quarters, warehouses, etc., are now in process of construction.

Taking into account the remote location of the concession, the lack of transportation and the multitude of auxiliary details that must be handled, the development of the field has been handled with remarkable speed and efficiency.

Just below Petrolea work is being actively

(Continued on page 120)

Left—Covenas terminal of the pipeline from Petrolea showing the former meat packing plant and pier. Below—". . . machines, aparatii and appurtenances" of Barco's original refinery.



Intensive Exploration Centers in MAGDALENA VALLEY

Socony-Vacuum, Shell, The Texas Company, Richmond and Others Are Carrying on Geophysical Exploration and Are Preparing to Drill in Colombia's Most Promising Region.

TWENTY-FIVE miles east of Puerto Wilches on the all-important Magdalena lies the camp of Aguas Claras on the Restrepo concession. In its attractive setting of palms and tropical vegetation, with extensive shops and warehouses, its geological laboratory and comfortable quarters this camp, owned by Socony-Vacuum, would be a revelation to a Texas wildcatter of 20 years ago. For, despite one small producer that supplies fuel for subsequent operations, Aguas Claras is still essentially a wildcat camp.

The camp is located 25 miles north of El Centro and approximately 75 miles southeast of the Barco concession. The concession of 50,000 hectares was purchased from Sr. Luciano Restrepo, Colombia's leading independent oil operator, who obtained it direct from the government after the Gulf had done some development work on the adjoining Las Monas area to the east and then allowed their concession to revert to the government.

Socony-Vacuum Oil Company de Colombia moved in in 1934. Adjoining the Restrepo concession on the north, Socony-Vacuum acquired through another subsidiary, Compania de Petroleo del Carare, another 50,000 hectare concession known as South Lebrija.

Some 550 men of which all laborers and 80 percent of the staff are Colombians, set to work to reconstruct the old Gulf camp, build roads and drill three comparatively shallow wells of which only one came in as a producer. The first, Las Monas No. 1, pumps 18 bbl. per day from 1,045 ft.: the second, Las Monas No. 1A, was abandoned as a dry hole at 3,479 ft. and on the third, Las Monas No. 3, drilling was suspended when no production had been found to 3,851 ft. although it might be worth deepening at some future date. These three wells lie at the eastern extremity of the concession.

The next step was to set up the rig for an important deep test which was known as Nariño No. 1 in the central part of the concession and which was drilled with one of the heaviest rotary rigs outside the United States. Nariño No. 1 was spudded in in June 1938 on indications obtained by seismograph. Although the well was prepared to go to 10,000 ft. formations ran deeper than expected and in February 1939 the location was abandoned as a result of a fishing job. The rig was moved to a new location northeast of Nariño at Peralonzo where it is now being spudded in.

The work on the Restrepo concession is under the direction of C. L. Clark with Andrew K. McGill acting as chief geologist. Socony-Vacuum de Colombia is represented in Bogota by C. P. C. Beresford, General Manager, and Dr. Carlos A. Torres-Pinzon. Rex Townsend, former general manager, was transferred to The Hague late in 1938.

A wildcat is also being drilled on the Sociedad Nacional del Carare concession which may be seen on the accompanying map adjoining the De Mares concession on the southwest. This company was organized by Colombian interests, the concession was obtained and the assistance of Tropical enlisted in the drilling campaign. Shares of the company are actively traded in on the Medellin exchange.

A 41 kilometer road was built from Piedra Linda on the Magdalena above Puerto Berrio to the first well location and the test was spudded in during the second half of 1938 but was subsequently abandoned. The company's plans call for the drilling of another wildcat.

Compania de Petroleo Shell de Colombia, subsidiary of the Anglo-Saxon Petroleum Company, Ltd., London, was organized as a Colombian company in November 1936 with a capital of 6,000,000 pesos. Directors are H. S. M. Burns, actively in charge of operations at Bogota, Ruben Jaramillo Arango, B. B. Parry and Daniel Trumpy of Bogota and F. Godber, G. Legh-Jones and the Hon. F. J. Hopwood of London.

In the short time since its foundation Shell has carried on a vigorous program of exploration including geological, gravimetric and seismological studies, over wide

Colombian workmen make good drillers after some training, are well paid, seem contented.

regions in various parts of Colombia. An extensive survey by aerial photographs has been made and is still being carried out.

Shell has acquired two national concessions of approximately 50,000 hectares each, in the Carare region of the Department of Santander, which is generally recognized as the center of oil interest in Colombia. One of these concessions was obtained by direct contract with the government, and the second by transfer from Senor Bernardo Mora of Medellin, a well-known Colombian industralist. Incidentally this latter concession was formerly held by the French Société Europeene de Petroles, but abandoned by them some years ago for lack of sufficient capital for the development.

of the Andes, and extends over the headwater region of the Orinoco and Amazon rivers. The region is relatively remote and considerable physical difficulties are expected to be encountered.

Shell has also been active in leasing private properties in the Magdalena valley in the Departments of Tolima, Caldas and Cundinamarca.

For the development of the national concessions in Santander, camps and river ports have been constructed, and the building of roads to the selected locations for the wells has been completed. In the case of the Mora concession a road of some thirty kilometers was constructed through a densely wooded and swampy region. A large quantity of modern road building machinery has been imported for this purpose. Although there are many small settlements along the banks of the Magdalena river, the area towards the interior is entirely virgin jungle with no signs of ever having been inhabited.

Left—Socony-Vacuum's Aguas Claras camp on the Restrepo concession. Below—Narino No. 1, the deep test on the Restrepo concession since moved to a new location.

The machinery and equipment is imported at Barranquilla and shipped directly from that port to Shell's river terminals by steamers of the flat-bottomed stern wheel

Shell has also had an application for a national concession of 100,000 hectares in the Llanos area accepted by the government. This is the first concession application to be accepted in this region which lies south and east of the Eastern Cordillera

type so familiar on the inland waterways of the United States. One rotary drilling rig has already spudded in some 38 kilometers east of Pto. Berrio. Another location is being prepared not far from Honda and geological or exploration drilling is expected to start soon. Both locations are indicated approximately on the accompanying map.

Shell is estimated to have spent a very substantial sum in acquiring leases and concessions and it is obvious that this will be an important development. When production is developed it will be necessary to construct a second pipeline down the Magdalena, probably terminating at a Caribbean port. Barranquilla, incidentally, is now being transformed into a port for sea-going vessels. When exploration further up the valley warrants, the line may be pushed further south and by that time developments on the Llanos concession of the Shell may justify the tremendous task of throwing a connecting line over the Eastern Cordillera which rises to an impressive height. The Llanos to Magdalena line if it is ever built should cross the Bogota sabana not far from the capital itself.

Right—Colombian workmen on one of the light Socony - Vacuum rigs with the palm shade in evidence. Below—Las Monas No. 3 on the road approaching the Aguas Claras camp.

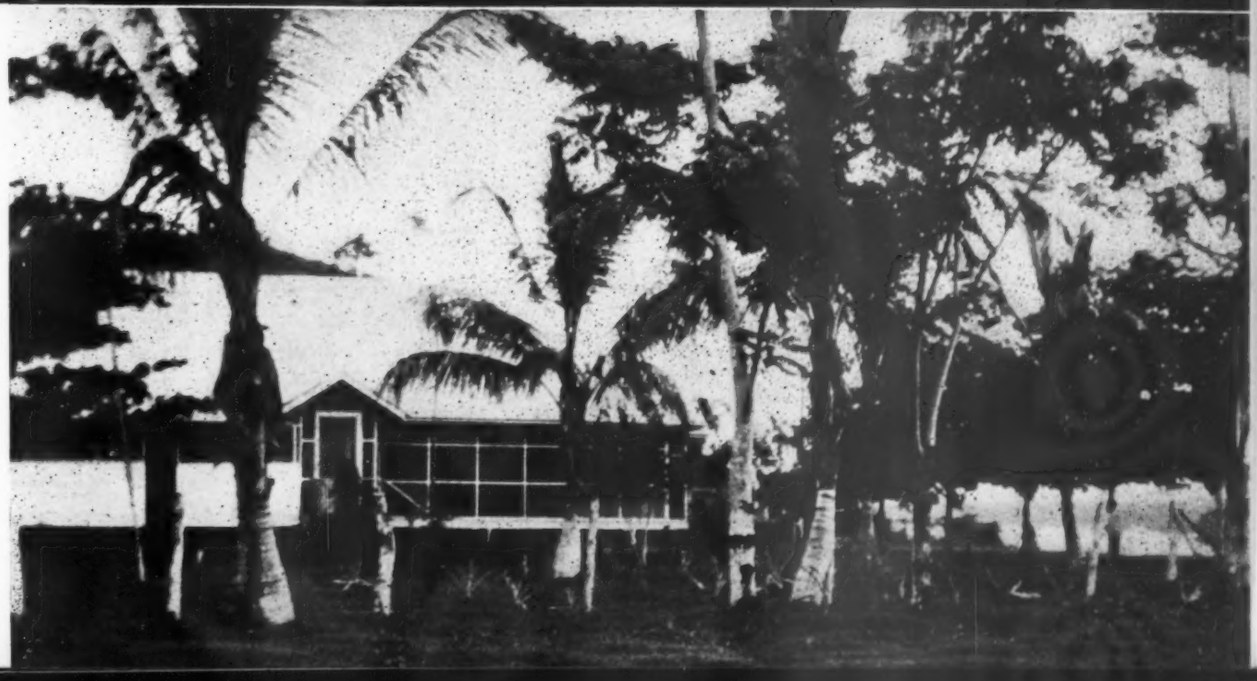
Rivaling, perhaps surpassing, Shell in its leasing and concession activity in Colombia is the Richmond Petroleum Company, subsidiary of the powerful Standard Oil Company of California. This company whose floating geophysical laboratory is a familiar sight on the Magdalena has specialized in private leases and its properties extend all the way up and down the Magdalena valley, cover a tremendous area in the Llanos region and include a 50,000 hectare concession near Simiti in the Department of Bolivar. Activity to date has consisted mostly of geophysical and geological exploration and mapping. Much of the work is directed by L. L. Tabor from head-

quarters at Ibaque although the company also maintains a Bogota office.

Like Socony-Vacuum, The Texas Company is developing properties in addition to its interest in the Barco concession. It holds some 240,000 hectares of prospective oil lands in Colombia under private titles, either in fee or under lease. These properties are all located in what might be called the Upper Magdalena Valley. A part of these holdings center around Ambalema; part of them near Honda; and the remainder, which is by far the larger part, is the Teran-Guaguaqui property at Puerto Boyaca.

Geological, geophysical and engineering work is being carried on by parties scattered through the various parts of Colombia. One seismic crew is in operation on the Teran-Guaguaqui properties and has to date provided approximately 100 kilometers of survey. A road 27 kilometers long has been constructed up the Rio Negro starting from Puerto Boyaca, located on the banks of the Magdalena River just north of Rio Negro. This road is partially gravel and its construction entailed the cutting of the road bed through hills with considerable grading, the installation of a large number of culverts, and the construction of several bridges. Tractor and mule trails are being cut through the virgin jungle to allow the geological and geophysical crews a means of ingress and egress. A crew of 200 to 400 men has been kept busy on this work. A power shovel, a tractor equipped with road building equipment, and three trucks constitute the mechanical equipment used to construct the road. The maintenance of supplies and materials requires the use of mules in pack trains, and approximately 150 mules are kept in constant service in the main camp, on the trails, and with the field parties.

The company fattens its own cattle at



Above—A general view of The Texas Petroleum Company's camp at Puerto Boyaca with the broad Magdalena in the background. Drilling operations will soon start on this big concession. Right—Casino at Puerto Boyaca.

The sign so familiar to motorists all over the world appears hundreds of miles up the Magdalena in Colombian jungles—but as there are no roads except those built by the company, this does not mean Texaco service to motorists as yet.

Puerto Boyaca and the slaughter house averages about 25 steers per month, with a crew of 300 men working. Large clearings have been made and planted with selected grasses to feed the cattle and the mules. Food supplies for the men cannot be purchased locally and must be brought down the river from Honda, or up the river from Puerto Berrio, Magangue, or Barranquilla. A vegetable garden is maintained to supply fresh vegetables for the main camp. The main camp has running water supplied by wells, and electricity which is supplied by a small gasoline and Diesel plant.

The geological and engineering field parties operating in the Teran-Guaguaqui and other areas are composed of geologists, geophysicists and engineers, and a party of chain men, rod men, cooks and laborers who stay out in the monte from a month to six months at a time, completing their tasks before returning to the settled areas.

A familiar sight on the Magdalena—Richmond's floating geophysical laboratory.

Geologist making his way in comfort up the boisterous Rio Negro on the Texas Company's Guagaqui properties.

While very active development has been stimulated in Colombia by the enactment of a fair and workable law and by various factors in the world situation, a review of the activities would be incomplete without reference to some of the development work that was undertaken without success in an earlier era of activity. Dr. Francisco Escobar reports on the lease acquired by the Atlantic Oil Company near Puerto Colombia about 1900. Despite several attempts no oil, but a little gas was discovered. As there was no market for the gas, the lease was abandoned.

A North American named Potts drilled several wells near Baranoa in Atlantico without success; the unfruitful efforts of Diego Martinez and Company of Cartagena are referred to elsewhere in this issue. But the Standard Oil Company of New York, many years ago drilled a 3,000 ft. test on lands belonging to Diego Martinez near the Sinu river, obtained no commercial production and withdrew.

Continental Oil Company drilled on lands at Simiti and near Honda and the Colombian Syndicate established a camp in Santander Sur and drilled a test but neither company succeeded in obtaining production. It must be borne in mind that each of these failures was far more costly than similar wildcats in more settled areas, in order to achieve a balanced point of view on the oil possibilities of a country like Colombia.

Oil Companies Pay 38% of Total
COLOMBIAN INCOME TAX

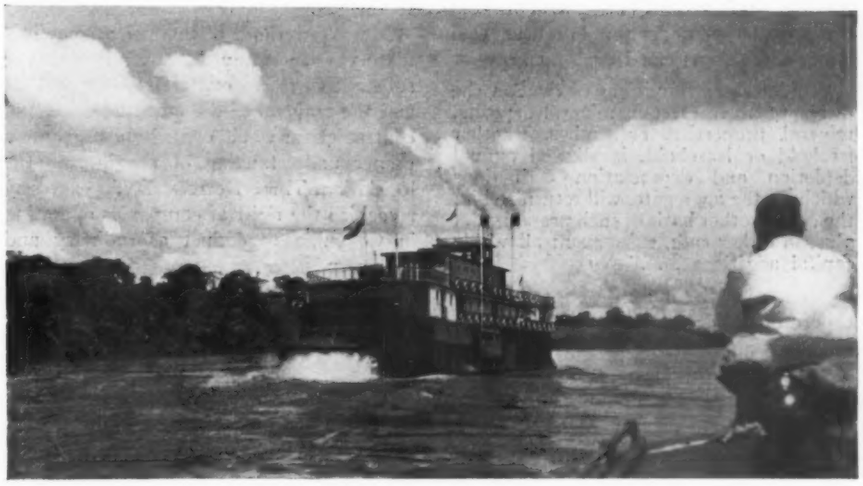
By James Raisbeck, Jr.

Modeled on U. S. Federal Income Tax Colombian Laws Omit Deductions for Losses or Obsolescence, Limits Depletion Allowance to 5% of Net Income.

FEBRUARY, 1939
BOGOTA, COLOMBIA

IN THE PAST, Colombia's principal source of revenue has been, and still is, derived from customs duties. In recent years, however, the revenue derived from Colombia's income tax legislation has played an increasingly important part in the fiscal and economic life of the country, and in the not distant future may well supplant the customs duties as the country's principal source of income.

The income from customs duties for the fiscal year 1939 is estimated in the Colombian budget at $30,000,000, (All money figures used in this article refer to Colombian pesos.) while the revenues from the income, patrimony and excess profits taxes are calculated at $18,000,000. During 1938 Colombian taxpayers paid into the National Treasury the sum of $18,200,000, which represents the income, patrimony and excess profits taxes collected for the taxable year 1937. Of this sum, the Tropical Oil Company paid approximately $5,000,000, the Andian National Corporation, Ltd., approximately $2,000,000, and the remaining oil companies, none of which is as yet an income producing company, probably paid in the neighborhood of $150,000 in capital or patrimony taxes. Thus, the oil companies paid 38 percent, more or less, of the total produced by Colombia's income tax legislation for the year 1937. The conclusion is, therefore, inescapable that Colombia's revenues may be expected to increase considerably when the major oil companies, now actively engaged in development work, reach the stage of commercial production. This stage, incidentally, has been reached by the Colombian Petroleum Company, which is actively developing the Barco Concession.



Typical stern-wheel Magdalena River boat.

With these preliminary observations out of the way, it may be well at this point to study and analyze Colombia's income tax legislation. In the first place, the income tax as such is, in its fundamentals, based primarily on the American Federal Income Tax Laws. There are, nevertheless, differences of importance between the two legislations. In Colombia, the income, patrimony and excess profits taxes constitute a trinity whose primary object is to tax income. Thus, the object of the capital or patrimony tax is not to tax capital as such, but to impose a higher rate of tax on income produced by capital. This has been the constant and consistent attitude of the government in interpreting the capital tax provisions of the law and the Supreme Court recently upheld this governmental interpretation.

The income tax is imposed on the net income of the taxpayer, that is, on the difference between his gross income and allowable deductions. The gross income, the exempt income and the allowable deductions are, in substance, those of the American Revenue Acts. In Colombia, however, there is no deduction permitted for obsolescence. Law 81 of 1931 allowed taxpayers a deduction for losses incurred in trade or business, as well as for losses arising from fires, storms, etc., but these deductions were, unfortunately, and without any satisfactory explanation, disallowed by Law 78 of 1935. Now it is quite evident that all persons or corporations engaged in business sometimes incur losses. For example, goods and automobiles are stolen; accidents occur to machinery and other property. Such losses are part of the hazards of industry, trade or business, and the American Revenue Acts recognize them as proper deductions from gross income to the extent not compensated for by insurance. It is indisputably clear that considerations of fairness to industry and business justify the reincorporation of these deductions into Colombia's tax legislation. The obsolescence deduction should also be expressly recognized by law. The Colombian taxpayer is not one whit less affected by the conditions which operate to cause obsolescence than the American taxpayer.

Law 78 of 1935 contains an express provision for an allowance for the depletion of natural deposits, but limits it to an amount not in excess of "five percent of the *net* income obtained by the taxpayer in the taxable year." This ill-considered limitation practically defeats the object of the allowance and should be eliminated in the interests of the oil industry and those engaged in the development of the country's natural resources. Its presence in the law is a constant reminder that Congress failed to understand the real theory of the allowance. As is well known, at all events by those connected with the oil and other extractive industries, the theory of depletion is that provision must be made for the

return of capital invested in natural resources which are being exhausted. From an economic standpoint there can be no net income until the original capital investment has been returned intact, or until adequate provision has been made therefor. The annual allowance for depletion, just as the corresponding deduction for depreciation, permits the taxpayer to recoup the capital value of the proprty exhausted during the process of exploitation. The general purpose of the depletion deduction has been well stated in the American Regulations:

"Under these provisions of the Act the owner of an interest in mineral deposits, mineral properties, or timber, whether freehold or leasehold, is allowed annual depletion and depreciation deductions which, in the aggregate, will return to him the cost or other basis of such property . . . plus, in either case, subsequent allowable capital additions . . ."

This admirably concise description of the purpose of the depletion deduction will be found to apply to each specific case. Operating owners, lessors, and lessees, whether corporations or individuals, are entitled to the depletion allowance. The character of the interest determines the right to the deduction and the value of the interest determines the amount of the deduction. It is a matter of minor importance that the Nation is the owner of the oil deposits. Actually, the Nation and the concessionaire hold separate property interests, between which there is no necessary relation so far as the depletion deduction is concerned. It is quite obvious, in view of the nature and object of the depletion deduction, that the concessionaire of nationally owned oil deposits, and the owner or lessee of privately owned deposits, should be entitled to recover their respective capital investments through depletion.

The five percent limitation in the depletion provision of Law 78 of 1935 should be eliminated to permit oil companies, whether concessionaires, owners or lessees of oil properties, to amortize fully and adequately their capital investments, in so far as they are amortizable by this provision.

The "percentage of income" basis of depletion, employed in the United States and Canada could be satisfactorily adapted to the Colombian system and would afford oil companies the opportunity to amortize their capital investments, which are recoverable through depletion.

It may be opportune, while discussing the depletion deduction, to call attention to the necessity of establishing clearly and defining in the Colombian Regulatory Decrees the right, not only of oil companies, but of all taxpayers, to capitalize their preliminary and development expenses in order that these may be amortized through depletion and/or depreciation deductions when the income producing stage is reached. The Colombian Regulatory Decrees do not clearly recognize that there are certain expenditures made during the period of development of a property which, if mandatorily deducted as expenses, result in large net losses during the period of development, so that the taxpayer does not get the benefit of such expenditures in the reduction of the net income subject to the tax.

Many provisions of the Colombian Regulatory Decrees are at variance with the substantive provisions of Law 78 of 1935 and the removal of the inconsistencies and contradictions would contribute largely to a proper understanding of the income tax legislation. These Decrees should expressly recognize the right of companies operating in Colombia to deduct as ordinary and necessary expenses a proper apportionment of head office expenses.

It has been previously stated that Colombia's income tax legislation is based essentially on the Federal Income Tax Laws. Colombia, however, does not impose an income tax on capital gains, nor does it allow capital losses as a deduction. National and foreign companies pay the tax only on income derived from sources within the country. Foreign corporations whose earnings are derived from operating ships under foreign flags are not exempt from the payment of the income tax in Colombia. Corporations, therefore, owning oil tankers which transport oil from Colombia to foreign ports are required to pay the income tax in Colombia. Colombia has not, either by treaty or law, exempted these corporations from the payment of its income tax.

The Colombian patrimony or capital tax is imposed on the net worth of the taxpayer, that is, on the difference between what he owns and what he owes. To be taxable, the patrimony must have its situs in Colombia. The progressive rates of the tax run from $1.00 per $1000 on net patrimonies over $10,000 to $8 per $1,000 when the net patrimony exceeds $400,000. It may be worth mentioning by the way that the rate of the Capital Stock Tax in the United States is US$1.00 per each US$1000 of valuation.

The excess profits tax in Colombia is imposed on profits which exceed 12 percent of the patrimony of the taxpayer at the end of his fiscal year. The taxpayer, however, can reduce the incidence of this tax to a minimum by requesting that the value of his good will and other intangibles be determined. The good will of the Tropical Oil Company has, for tax purposes, been valued at approximately $30,000,000 and that of the Andian National Corporation, Ltd., at approximately $18,000,000.

The income tax rates run progressively from one percent up to 17 percent, this latter figure being applicable to incomes in excess of $600,000. Both individuals and corporations pay the same progressive tax rates. Stockholders, however, do not pay the tax on corporate dividends.

Ordinary credits have their situs, for patrimony tax purposes, in the domicile of the debtor. This, at all events, has been the constant attitude of the Ministry of Hacienda. Thus, if Company "A", in New York, advances funds to its subsidiary, Company "B," in Colombia, the former is taxable in Colombia on the balance outstanding at the end of the taxable year.

Summing up, the Colombian income, patrimony and excess profits taxes have definitely taken root in the country's political economy. So far, the tax legislation has worked out fairly well in practice, but the need exists for modifications which will harmonize its conflicting provisions and bring it into line with business realities and commercial usage. The depletion deduction should be carefully and technically regulated by decree. The Resolutions of the Ministry of Hacienda on tax matters should be published so that taxpayers could acquaint themselves with the rulings which interpret the revenue acts. As to possible changes in the tax legislation EL TIEMPO (leading Bogota daily) recently published an interview with the Commissioner of Internal Revenue or Jefe de Rentas who is reported to have stated that the tax rates on income and patrimony were somewhat low. This opinion probably does not represent the views of the present administration. At all events, it may not be out of place to conclude this article with a citation taken from the article by Godfrey N. Nelson in the New York TIMES of July 24th, 1938.

"The late President Wilson was the first Chief Executive who recognized that excessively high tax rates can be 'destructive of business activity and productive of waste and inefficiency.' In a message to Congress, based on a report of the Secretary of the Treasury, he said: 'There is a point at which, in peace times, high rates of income and profits taxes discourage energy, remove the incentive to new enterprise, encourage extravagant expenditures, and produce industrial stagnation with consequent unemployment and other attendant evils.' . . . . . By reference to statistics of income issued by the Treasury it has been shown that not only have the reported incomes in the higher brackets diminished as and when rates were increased, but the number of such returns has decreased; and that when the tax rates were decreased the amounts reported in the higher brackets, as well as the number of returns reporting in those brackets, have substantially increased."

GEOLOGY of Middle and Upper Magdalena Valley

By John W. Butler, Jr.

While the Study of Geological Features of Colombia Is Still in Its Infancy, World Petroleum Is Privileged to Publish in the Accompanying Article a Thorough-going Summary of Present Knowledge of Most Important Oil Region in Colombia to Date.

PHYSIOGRAPHICALLY, Colombia may be roughly divided into a western third which is characterized by the high, rugged Andian ranges separated by deep, narrow valleys, and an eastern two-thirds which is characterized by the flat Llanos or plains country.

The Andes strike northward through Ecuador as a single range, but upon entering Colombia the mountain chain branches at the "Pasto Knot" into three principal northward continuations: the Cordilleras Oriental (Eastern), Central, and Occidental (Western). The Eastern and Central ranges are separated by the long, deep valley drained by the Magdalena River; the Central and Western ranges are separated by the equally impressive Cauca Valley. A fourth, shorter, range, the Cordillera of Choco, appears along the Pacific coast, extending from near Buenaventura northward to Panama. The three principal Andian ranges strike more or less north-northeast and the Western and Central ranges die out before reaching the Caribbean coast. The Magdalena River Valley swings northwestward around the northern end of the Central Cordillera and then north again to the sea. For that reason a wide, low, swampy area exists between the Central range and the isolated Sierra de Santa Marta on the coast. Many consider this latter mountain group to be a northern continuation of the Central Cordilleras. The Eastern Cordillera swings northward in the Bucaramanga-Ocana area and then continues north-northeast again in the form of the Cordillera de Perija which forms the boundary between Colombia and Venezuela. Near Cucuta a branch of the Eastern Cordillera swings eastward into Venezuela to become the Merida range. The Maracaibo basin of northeastern Venezuela lies in the forks between this latter extension of the range and the Cordillera de Perija.

The Llanos are sparsely settled plains country of less than one thousand meters altitude; only a few low hills are scattered throughout this area. Tributaries of the Orinoco and Amazon Rivers head in the eastern slopes of the Cordillera Oriental and flow eastward across the Llanos.

Geologically, the Choco, Western, Central, and the isolated Santa Marta mountains are composed of plutonic and metamorphic rocks. However, lower Tertiary rocks have been reported from the region near Cali in the Western Cordillera and along the Pacific coast; Mesazoic strata are thought to occur within the Cordillera Central. The Cauca Valley is generally considered to be a graben in an old-landmass, the remnants of which are represented by the four above-mentioned Cordilleras. Volcanism took place during the late Tertiary and the Quaternary in the Cordillera Central.

The Cordillera Oriental is composed mostly of thick Cretaceous formations, although small patches of sedimentary rocks of Paleozoic and older Mesazoic ages are recorded in places. Plutonic and metamorphic rocks also crop out in places. The range seems to be a folded geosynclinal zone. The Cordillera de Perija and the Cordillera de Merida have lithologies similar to the Cordillera Oriental. The low coastal area along the Caribbean Sea and that region south of the Sierra Nevada de Santa Marta are covered for the most part by younger marine Tertiary strata. Tertiary formations, mostly of lacustrine or continental origin, crop out within the Magdalena Valley; and younger Tertiary and Quaternary continental sediments cover the Llanos area.

Four regions are of interest for their petroleum possibilities:

1. The Coastal Region which flanks the Caribbean Sea;
2. The Magdalena Valley;
3. The Catatumbo Region which lies west and southwest of the Maracaibo area; and
4. The Llanos.

A fifth possibility is the narrow area along the Pacific coast which has not received serious consideration as yet.

Colombia's sole production comes from the Middle Magdalena Valley, but recent drilling has favorably proved the Catatumbo region, which awaits only completion of a pipeline in order to become a commercially producing field.

Considerable exploration is underway at present in both the coastal and Llanos areas.

MAGDALENA VALLEY

The oil producing possibilities of the Middle and Upper Magdalena Valley districts of Colombia, have received attention ever since exploration for petroleum began in the country and in recent years this interest has increased considerably. At

Road, pipe and ditcher along the Petrolea-Covenas pipeline right of way. The line is expected to be completed this summer.

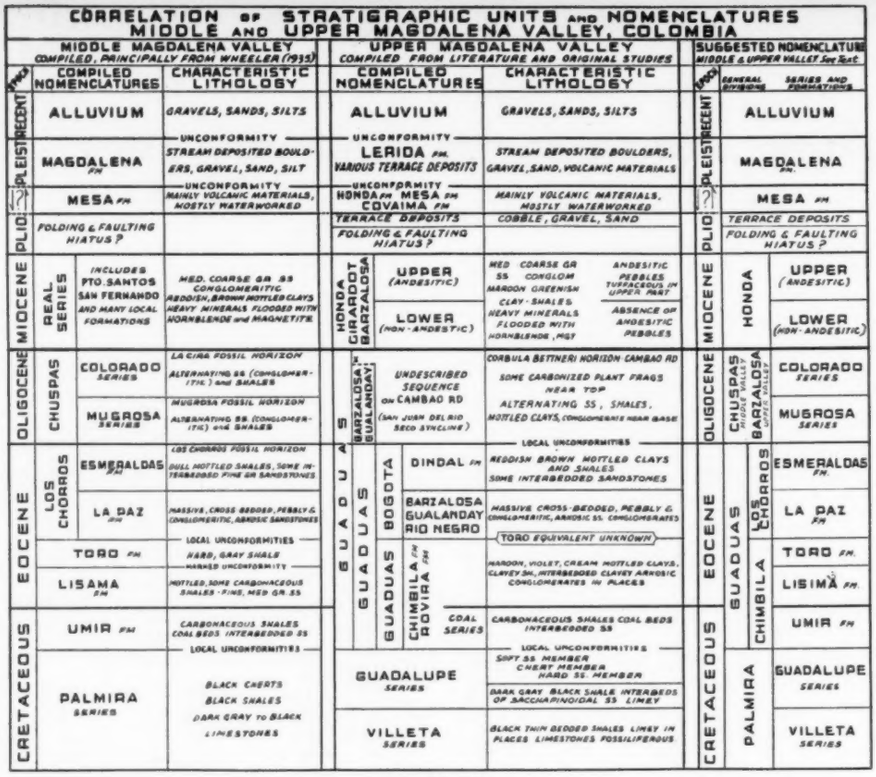

CORRELATION OF STRATIGRAPHIC UNITS AND NOMENCLATURES
MIDDLE AND UPPER MAGDALENA VALLEY, COLOMBIA
MIDDLE MAGDALENA VALLEY
COMPILED, PRINCIPALLY FROM WHEELER (1935)
UPPER MAGDALENA VALLEY
COMPILED FROM LITERATURE AND ORIGINAL STUDIES
SUGGESTED NOMENCLATURE
MIDDLE & UPPER VALLEY See Text
AGE
COMPILED NOMENCLATURES
CHARACTERISTIC LITHOLOGY
GENERAL DIVISIONS
SERIES AND FORMATIONS
ALLUVIUM
GRAVELS, SANDS, SILTS
UNCONFORMITY
MAGDALENA FM
STREAM DEPOSITED BOULDERS, GRAVEL, SAND, SILT
LERIDA FM.
VARIOUS TERRACE DEPOSITS
STREAM DEPOSITED BOULDERS, GRAVEL, SAND, VOLCANIC MATERIALS
MESA FM
MAINLY VOLCANIC MATERIALS, MOSTLY WATERWORKED
HONDA FM MESA FM COVAIMA FM
MAINLY VOLCANIC MATERIALS, MOSTLY WATERWORKED
TERRACE DEPOSITS
COBBLE, GRAVEL, SAND
FOLDING & FAULTING HIATUS?
PLEISTOCENE
PLIOCENE
MIOCENE
REAL SERIES
INCLUDES PTO. SANTOS SAN FERNANDO AND MANY LOCAL FORMATIONS
MED. COARSE GR SS CONGLOMERITIC REDDISH, BROWN MOTTLED CLAYS HEAVY MINERALS FLOODED WITH HORNBLENDE and MAGNETITE
HONDA
GIRARDOT
BARZALOSA
UPPER (ANDESITIC)
LOWER (NON-ANDESITIC)
RED COARSE GR SS CONGLOM MAROON GREENISH CLAY-SHALES HEAVY MINERALS FLOODED WITH HORNBLENDE, MGT
ANDESITIC PEBBLES TUFFACEOUS IN UPPER PART
ABSENCE OF ANDESITIC PEBBLES
OLIGOCENE
CHUSPAS
COLORADO SERIES
LA CIRA FOSIL HORIZON
ALTERNATING SS (CONGLOMERITIC) and SHALES
MUGROSA SERIES
MUGROSA FOSIL HORIZON
ALTERNATING SS (CONGLOMERITIC) and SHALES
BARZALOSA (LOWER PART)
GUALANDAY
UNDESCRIBED SEQUENCE ON CAMBAO RD
(SAN JUAN DEL RIO SECO SYNCLINE)
CORBULA BETTNERI HORIZON CAMBAO RD
SOME CARBONIZED PLANT FRAGS NEAR TOP
ALTERNATING SS, SHALES, MOTTLED CLAYS, CONGLOMERATE NEAR BASE
LOCAL UNCONFORMITIES
EOCENE
LOS CHORROS
ESMERALDAS FM
LOS CHORROS FOSIL HORIZON
DULL MOTTLED SHALES, SOME INTERBEDDED FINE GR SANDSTONES
LA PAZ FM
MASSIVE, CROSS BEDDED, PEBBLY & CONGLOMERITIC, ARKOSIC SANDSTONES
TORO FM
LOCAL UNCONFORMITIES
HARD, GRAY SHALE
MARKED UNCONFORMITY
LISAMA FM
MOTTLED, SOME CARBONACEOUS SHALES - FINE, MED GR SS
GUADUAS
BOGOTA
DINDAL FM
REDDISH BROWN MOTTLED CLAYS AND SHALES SOME INTERBEDDED SANDSTONES
BARZALOSA GUALANDAY RIO NEGRO
MASSIVE CROSS-BEDDED, PEBBLY & CONGLOMERITIC, ARKOSIC SS. CONGLOMERATES
TORO EQUIVALENT UNKNOWN
CHIMBILA FM ROVIRA FM
MAROON, VIOLET, CREAM MOTTLED CLAYS, CLAYEY SS, INTERBEDDED CLAYEY ARKOSIC CONGLOMERATES IN PLACES
COAL SERIES
CARBONACEOUS SHALES COAL BEDS INTERBEDDED SS
CRETACEOUS
UMIR FM
CARBONACEOUS SHALES COAL BEDS INTERBEDDED SS
LOCAL UNCONFORMITIES
PALMIRA SERIES
BLACK CHERTS BLACK SHALES DARK GRAY to BLACK LIMESTONES
GUADALUPE SERIES
SOFT SS MEMBER CHERT MEMBER HARD SS MEMBER
DARK GRAY BLACK SHALE, INTERBEDS OF SACCHAROIDAL SS LIMEY
VILLETA SERIES
BLACK THIN BEDDED SHALES LIMEY IN PLACES LIMESTONES FOSSILIFEROUS

Table 1

present the sole commercial production in Colombia comes from the Middle Valley.

Publications show that the geology of the region as a whole is little understood and offers many problems. Successful detailed stratigraphical correlations are lacking, as yet, and the present nomenclature, which includes a confusion of definitions and terms, requires revision. These difficulties principally exist because up to the present, with few exceptions, the literature on the region contains only the results of scattered or cursory studies.

The strata, already complicated by lateral variations in facies, have had their relationships further obscured by complex faulting and folding. The Tertiary section is mainly of continental origin so that fossil horizons useful for correlation are rare. Final unraveling of the geology awaits the accumulation of detailed data.

The present article is confined to a summary of the known available geological data of the Upper and Middle Valleys and presents a tentative correlation between the two regions according to the writer's interpretations as outlined in Table 1.

The part of the Magdalena Valley which is to be discussed forms an impressive deep, narrow, long interandian lowland, flanked on the west by the Cordillera Central and on the east by the Cordillera Oriental; two long, narrow ranges of different stratigraphy and geological history.

The Cordillera Central is the remnant of an old land mass comprising folded and faulted sediments and meta-sediments, generally assigned to the Paleozoic and younger ages, which were invaded by plutons of granitic and dioritic composition with their relations and derivatives. Erosion penetrated down to the igneous rocks and developed a surface which the Mesazoic and Tertiary sediments overlapped from the east; the shore line apparently was more or less parallel to that of the present Magdalena Valley.

The Cordillera Oriental, as now known, comprises a thick series of folded and faulted Cretaceous and Eocene sediments that evidently represent a folded geosynclinal zone which formerly lay east of, and more or less parallel to, the present Cordillera Central. Older paleozoics and plutons crop out in places, such as in the region of Villavicencio and Guachalá in the states of Cundinamarca and Meta, and in parts of the Department of Santander. These areas show that the form of the geosynclinal area was not simple and is as yet little understood. An additional feature of Tectonic significance is the widespread mineralization throughout the Cordillera Oriental, as attested by the emerald deposits of Muzo and Chivor, and numerous small zinc, lead and copper deposits scattered throughout the zone of sedimentary rocks. The deposits seem to have been formed by emanations escaping from a post-Cretaceous batholith underlying the Eastern Cordillera. Notwithstanding this evidence of deep-seated igneous activity, asphalt and petroleum seeps are known throughout the higher Cordillera, those in the region of Sogamoso having supplied asphalt locally for years.

Within the Magdalena Valley proper are found sediments that range in age from possibly Paleozoic to Recent. As a general rule, the Tertiary formations thicken rapidly from west to east. From the stratigraphical point of view, the valley is distinctive by virtue of the fact that considerable thicknesses of Middle and Upper Tertiary strata are present, whereas they are lacking, or have not been recognized, within the Cordilleras.

Zoning of the Tertiary sediments is described by some workers who emphasize a gradational change from the marine types of the Lower Valley to estuarine types of the Middle Valley, and finally to lacustrine types of the Upper Valley. A transition from marine to non-marine sediments is evident. However, most of these descriptions are based upon the assumption that the Magdalena Valley was outlined at the close of the Cretaceous; an assumption already criticized by F. B. Notestein in view of the thick remnants of Eocene strata infolded high within the Cordillera Oriental. Future work may show that even the thick section of continental Honda series (Miocene?) clastics were deposited an appreciable distance within the interior of the present Cordillera Oriental.

Inasmuch as the most detailed stratigraphical information is available for the Middle Valley of the Magdalena River, it seems most practical to describe that section first, then to summarize the scattered and conflicting data available on the Upper Valley Region. Finally, a tentative correlation between the Middle and the Upper Valley is made in order to present a unified picture of the mutual relationships.

MIDDLE VALLEY

The Middle Valley region begins in the vicinity of El Banco, about 230 kilometers above the mouth of the Magdalena River, and extends upstream some 450 kilometers to the Honda-La Dorada district, page 99. The latter area marks the boundary between the Middle and Upper Valley.

O. C. Wheeler has given the most detailed account of the Tertiary stratigraphy of the Middle Magdalena Valley and information is freely drawn from his article for the following review of the region[1].

BASEMENT ROCKS. The metamorphic and igneous rocks that are exposed in the Cordillera Central along the western margins of the Magdalena Valley include schists, phyllites, slates, gneisses, quartzites, marbles, granite, granodiorite, diorite, monzonite, syenite, various porphyries, lamprophyres, etc. Graptolites reported to be of Ordovician age have been found in slate near Puerto Berrío.

[1] "Tertiary Stratigraphy of the Middle Magdalena Valley," by O. C. Wheeler—From "Tertiary Fresh-Water Mollusks of the Magdalena Embayment, Colombia" by Henry A. Pilsbry and Axel A. Olsson—Proceedings of Academy of Natural Sciences of Phila., Vol. LXXXVII, 1935, pages 7-39, Apr. 23, 1935.

Metamorphic and plutonic rocks form the core of the Cordillera Oriental, but have been reported upon only in Santander and northward, and near Villavicencio and in southern Cundinamarca.

GIRON SERIES. The oldest unaltered sediments of the Cordillera Oriental are the little known Giron series. They comprise non-fossiliferous white, gray and red sandstones and shales over 3,000 meters thick. The age of the series is in doubt, being variously stated as Lower Cretaceous, Jurassic, or even older.

PALMIRA SERIES. (Cretaceous) Wheeler describes the bulk of the Cretaceous sediments under the term "Palmira series." They comprise a 2,200 meter section of alternating "black shales and gray to black limestones and black cherts of lower and upper Cretaceous age."

UMIR FORMATION. (Upper Cretaceous) Unconformably overlying the Palmira series is the coal-bearing Umir formation. It consists of a sequence of dull blue and bluish-black, well bedded carbonaceous shales that vary in thickness between 900 and 1,200 meters. In the upper 300 meters coal beds up to a few feet thick are interstratified with thin, fine-grained greenish and brown ripple marked sandstones and lenses of clay ironstone. The Umir formation is thought to be equivalent to the coal-bearing strata of the Guaduas series of the Bogota district and Upper Valley, and to the Third Coal Horizon of Venezuela.

On the basis of a study of fauna collected by P. L. Merritt, H. N. Coryell and D. Malkin recently showed the Umir in the Lebrija district to be of uppermost Cretaceous (Navarro) age.

LIZAMA FORMATION. (Lower Eocene) The Lizama formation consists of mottled shales in which are interbedded minor amounts of dull colored carbonaceous shales, occasional coal beds, and some fine- and medium-grained sandstones. The sediments are generally coarser than those of the Umir and mark a transition between the uppermost Cretaceous, which comprises alternating marine and non-marine beds, and the continental deposits typical of the rest of the Tertiary section in this region. The formation overlies the Umir with apparent conformity, but a major unconformity followed Lizama times. Thickness: some 1,050 meters. On the basis of the uppermost Cretaceous age of the Umir, the Lizama formation is here tentatively dated as lower Eocene.

TORO FORMATION. (Middle? Eocene) The Toro formation, or "altered shale," comprises a maximum thickness of 18 meters of "hard, dense, gray to light grayish-blue, highly-jointed shale" usually massive, although extremely fine-bedded in places. It is thought, but not proven, to be of volcanic origin. The formation becomes sandy and less resistant north of the Rio Sogamoso and finally disappears; it has not been observed south of the Opon River.

The Toro formation lies unconformably on strata ranging from Lizama down to Palmira in age. Small local unconformities mark the top.

CHORRO SERIES. (Middle? and Upper Eocene) The Chorro series includes mottled shales and clays, sandstones and conglomerates. Thicknesses increase rapidly eastward from about 390 meters up to at least 1,950 meters. The top is marked by the fossiliferous Los Corros zone.

In many places the Chorro series may be divided into a lower La Paz formation and an upper Esmeraldas formation. The La Paz formation is characterized by the coarse texture of its clastics, being dominantly "massive, coarsely cross-bedded, pebbly and conglomeritic sandstones." It is 900 meters thick near Santa Marta on the Sogamoso River. The Esmeraldas formation overlies the La Paz with apparent conformity and is dominantly of shaley lithology. In places it contains plant remains. The Los Corros upper Eocene fossil horizon marks the top. The formation is 1,050 meters thick near Santa Marta.

CHUSPAS GROUP. (Oligocene) Many of the petroleum geologists refer to the aggregate of the Oligocene strata in the Middle Valley region as the "Chuspas formation." However, in spite of widespread field usage, the name has appeared in print only once, on which occasion it was the subject of a study by Karl Ermisch.

In the western part of the Department of Santander sediments assigned to the Oligocene have accumulated to thicknesses ranging from 900 to 3,660 meters. In that district Wheeler recognized two series of alternating sandstones and shales: the lower Mugrosa and the upper Colorado series. The top of each series is marked by a fossil horizon called the Mugrosa and La Cira horizons, respectively. The Mugrosa fossils seem characterized by *Hemisinus* sp. The La Cira fauna is the most abundant and widespread of any of the mentioned Tertiary fossil horizons, and includes a curious mixture of fresh and brackish water forms which are thought by H. A. Pilsbry and A. A. Olsson to be of upper Oligocene or lowest Miocene age.

The Colorado series differs from the Mugrosa as a unit in that the shales are stained with brighter hues of red, and the sandstones are coarser and more conglomeritic.

REAL SERIES. (Miocene) Throughout the Middle and Upper Valley there occurs a thick sequence of continental deposits comprising mostly coarse-grained sandstones and conglomerates with some thin interbeds of mottled, purplish-maroon and olive drab clays and clay shales. Fossil wood is present in places.

Wheeler gives the name "Real series" to this sequence in the western part of the Department of Santander. The Miocene age is based upon stratigraphic position and the presence of some plant remains which, according to E. W. Berry, resemble Miocene forms. The Real series is about 3,810 meters thick in the Opon River region.

The strata have been divided by various workers into distinct formations that bear names such as San Fernando and Puerto Santos but, unfortunately, confusion exists in the application of these names, so that it seems more practical to reserve subdivision for the future. Quite detailed divisions have been made on the Tropical Oil Company fields, but they admittedly are of very limited lateral extent and, therefore, do not offer units that promise widespread correlation.

MESA FORMATION. (Pliocene or early Pleistocene?) No definitely proven Pliocene sediments exist in the region. The Mesa formation of the Honda district, an alluvial plain formation which originated from the Cordillera Central, is considered by many to be of Pliocene age on stratigraphical and structural grounds. No type locality has ever been stated for the Mesa formation, although descriptions in the literature leave no doubt that the term refers to the almost horizontal beds that are particularly well exposed around Honda, at the limits of the Upper and Middle Valley. There the Mesa formation principally comprises ash, pyroclastics and mixed sediments, mostly water-worked, but all containing abundant andesitic and dacitic material, and ashy in character. Some boulder, cobble and gravel lenses are present. The formation has an exposed thickness of 300 meters in the Alto del Gigante, northwest of Honda.

Inasmuch as the Mesa formation was deposited after the thick Miocene section was strongly folded, faulted and eroded, there seems to be a reasonable probability that it is latest Pliocene or earliest Pleistocene in age.

QUARTERNARY. Most widespread of the Quarternary deposits is the Magdalena formation, consisting of river gravels and boulders, into which the present Magdalena River and the lower courses of its tributaries are entrenched. It is exposed for thicknesses of 60 meters and more.

Some terrace deposits are also of this general age.

UPPER VALLEY

The Upper Valley region of the Magdalena River extends more than 400 kilometers south of the Honda district. As in the case of the Middle Valley, later Ter-

tiary sediments are the most widespread in the Upper Valley. One of the most conspicuous occurrences of Cretaceous and early Tertiary rocks is in the group of northeast-southwest striking ridges which continue diagonally southwestward across the valley from the vicinity of the Rio Seco near Guataqui to south of the Rio Luisa. The Magdalena River has entrenched itself in a narrow valley near Guataqui across the resistant ridge forming rocks; in fact, this group of ridges roughly subdivides the Upper Valley.

Plutonic rocks are exposed at many places along the foothills of the Cordillera Central, and in the Ibague-Payande-Rovira (Miraflores) district they have been intruded into limestones and quartzites.

A striking feature of the Upper Valley region is the widespread occurrence of the Mesa formation, which actually is an alluvial plain deposit of variable thicknesses, as noted above. This formation complicates geological studies by burying many of the older rocks.

An unconformity is reported within the upper Cretaceous (Guadalupe-Guaduas contact) west of Bogota and southward in the Upper Valley. However, conformable relationships are exhibited in the Los Alpes district of the Rio Negro, and apparently so in the vicinity of Bogota, well within the Cordillera Oriental. Other unconformities are reported between the Guaduas and the overlying Barzalosa series, and at the bottom of the Miocene Honda series.

The foundations of stratigraphical nomenclature in the Upper Valley were laid by Hettner in 1892. Unfortunately, his descriptions were brief and no precise limits were stated for his stratigraphical units. Gradually his terms came to have a variety of usages so that they now serve only as broad, general names. An attempt is made in the following summary to restrict Hettner's terms to their original significance as closely as practical.

BASEMENT ROCKS. Paleozoic and plutonic rocks in the Upper Valley region have received little attention other than recognition of their existence. Hettner's Quetame series of highly folded quartzites and phyllites occurs in the eastern part of the Cordillera Oriental near Villavicencio. Some fossiliferous limestones are reported to the northeast.

Post-lower and middle Cretaceous (Villeta) plutonic igneous activity in the Cordillera Oriental is indicated by the presence of the emerald mines of Muzo, Chivor, and numerous small lead, zinc and copper mines. Granitic, dioritic, syenitic and associated dike rocks crop out in the foothills of the Cordillera Central. In many places from Honda south to at least the Rio Coello, the plutonics represent an old erosion surface of at least pre-Guaduas age.

GIRON SERIES. Small local outcrops of red beds assigned to the Giron are reported within the flanks of the Cordillera Oriental. The majority of workers in the Upper Valley are inclined to regard these beds as lowest Cretaceous.

GUADUAS GROUP. (Hettner, 1892, Uppermost Cretaceous-Upper Eocene) The usage of the term "Guaduas" is at present subject to considerable confusion. It is variably applied to include strata ranging in age from uppermost Cretaceous (Navarro) to upper Oligocene. Hettner's original use of the term (1892) seems to have been applied to reddish colored and mottled shales and coal-bearing strata. Hence, the writer is inclined to limit the Guaduas group to include strata which have been shown by recent studies to range in age from uppermost Cretaceous (Navarro) to the close of the Eocene.

The Guaduas contains the exploited coal of the Bogota region. The lithology is variable, including clays, shales, sandstones and conglomerates, but in general there seems to be an arrangement of strata in three divisions as follows: a lower part in which the coal horizons occur, the conspicuous lithology being gray shales; overlying this is a member in which sandstones and fine-textured conglomerates form the predominant lithology; the top member is marked by the dominance of reddish and mottled clays and shales. The continental origin of the strata makes long range correlations difficult. Nevertheless, the writer recognizes the possibility that these three divisions give promise of correlation with the formations in the Middle Valley and Venezuela.

The lower division may be called the Chimbilá, following J. de Mier Restrepo who recently described an occurrence about 377 meters thick at Chimbilá on the Rio Negro near Los Alpes, Cundinamarca. This series is probably equivalent to the Third Coal Horizon of Venezuela. It comprises mottled clays, shales, and minor amounts of sandstones, with coal beds in the lower part. The coal member is correlated with the Umir, although E. W. Berry judged a scant flora collected in the vicinity of the Sabana de Bogota to indicate an upper Eocene or Oligocene age. The writer agrees with F. M. Anderson, that too scanty evidence was available for Berry's conclusions. It may well be that the coal beds of the Sabana are younger than those in the Umir of the Middle Valley, but no such great difference in age seems in accord with the observable stratigraphy. The upper part of the Chimbilá is thought to be equivalent to the Lizama of the Middle Valley.

The middle division of the Guaduas, mentioned above, is tentatively correlated with the La Paz of the Middle Valley and with the Mirador of Western Venezuela and the Llanos district of Colombia.

Relationships in the Middle Valley suggest that the distribution of the Toro formation southward was limited, or that a change of facies prevents differentiating it as a unit. In the latter case it is probably included in the bottom of the "La Paz" of the Upper Valley.

The upper division of mottled clay and shale lithology is thought to be equivalent to the Esmeraldas formation of the Middle Valley.

The three divisions are well exposed in Dindal Creek on the Rio Negro. No definite continuation of the Los Corros upper Eocene fossil horizon has yet been found, or definitely so identified.

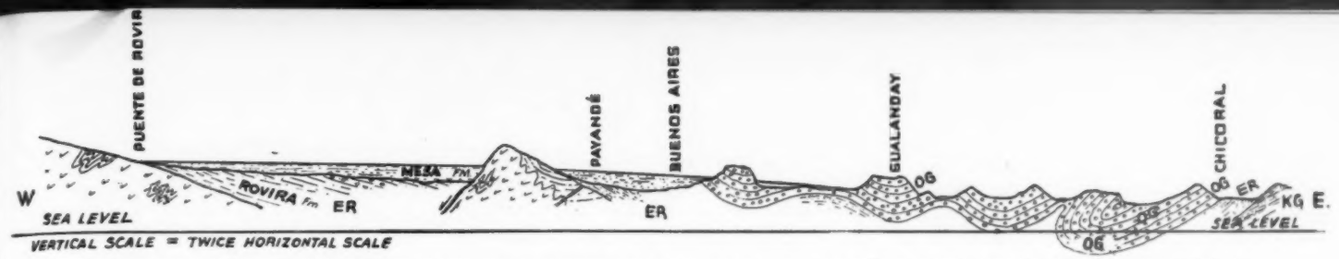
North of Tocaima an incomplete section reported to exhibit these divisions is about 400 meters thick. Near Zipaquirá, within the Cordillera Oriental, a section representing still less of a stratigraphic interval is reported to be about 2,000 meters thick.

The Guaduas overlies the Guadalupe unconformably in the region of Girardot and elsewhere in the Upper Valley, but seems to be conformable when not in fault contact within the Cordillera Oriental near Bogota.

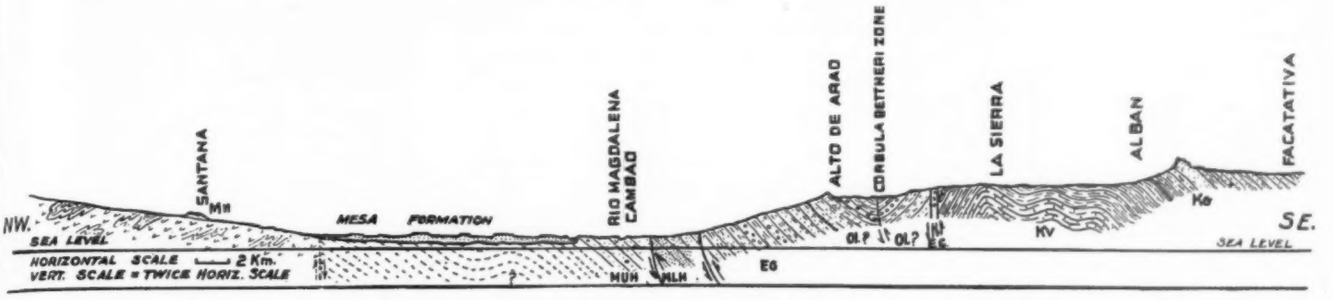
BARZALOSA-GUALANDAY SERIES. The significance of the terms "Barzalosa" and "Gualanday" has beocme almost as confused as that of the term "Guaduas."

Robert Scheibe, as chief of the old Comision Científica, suggested the name "Barzalosa" for a series of non-marine clastics that overlie the Guaduas with unconformity in the Girardot region, east of the Magdalena River. G. Lleras Codazzi describes 320 meters of these sediments which seem divisible into three parts. The lower zone is characterized by coarse conglomerates whose pebbles are predominantly chert of the Guadalupe series; sandstones and mottled shales also are present. At the type locality this member attains to a thickness of about 160 meters. The central division consists of some 40 meters of bluish shales that contain many veinlets of gypsum. The third, upper, division is a series of mixed clastics comprising red, yellow, brown and gray clays and shales, sandstones, and pebble conglomerates, about 120 meters thick, the top having been removed by erosion. Septarian concretions are present.

Scheibe named a series of similar appearance on the west side of the Magdalena River the "Gualanday formation." G. Lleras Codazzi estimated that at least 1,200 meters of the formation is exposed. The series is dominantly conglomerates and sandstones. Many of the pebbles are 6 cm. in diameter and, as in the case of the



EAST-WEST GEOLOGICAL CROSS-SECTION OF MAGDALENA VALLEY IN THE IBAQUE-GUALANDAY-CHICORAL REGION



NORTHWEST-SOUTHEAST GEOLOGICAL CROSS-SECTION OF MAGDALENA VALLEY FROM SANTANA TO FACATATIVA

Barzalosa formation, chert fragments are quite conspicuous but volcanic pebbles are entirely absent. Reddish shales occur throughout, but seem most conspicuous near the bottom.

Scheibe believed the Barzalosa and Gualanday to be equivalent, and possibly lower Honda in age inasmuch as the absence of andesitic fragments indicated deposition before the advent of volcanism. However, he was inclined to retain separate names for the formations until field work proved their relationships.

CORBULA HETTNERI horizon: F. M. Anderson described fossils collected for him from a locality on the road between Facatativa and Cambao on the Magdalena River. *Corbula hettneri* Anderson, a small peculiar clam with angulated umbones, is an abundant species in the horizon and suggested the name here applied.

Anderson considered the fossils to be Eocene (Guaduas) on the basis that coal was reported nearby. The writer observed no Guaduas coal in the district, although more than 6,000 meters of stratigraphic section is exposed below the fossil horizon. The occurrence of the fossils is not unlike that of the prolific upper Oligocene or lower Miocene La Cira horizon in the Middle Valley. The stratigraphy of the Cambao road has not been worked out in detail, but in a general way it is composed of alternating sandstones, mottled maroon shales and clays, and pebble conglomerates. The writer tentatively correlates the *Corbula hettneri* horizon with the La Cira fossil horizon of the Middle Valley and judges the fossiliferous strata to be at the top of what may be Scheibe's Barzalosa series.

GIRARDOT SANDSTONE. The sandstones and interbedded red and mottled shales which crop out near Girardot were considered by the old Comision Cientifica to overlie the Barzalosa beds, although the relationships were never actually worked out. A similar sandstone formation has been described overlying the Gualanday beds. These strata were called the Girardot sandstones and Scheibe considered them to be the lower part of the Honda series. Later (1926) F. Weiske applied the term "Girardot formation" to the younger Honda series of this article.

HONDA SERIES. The Miocene epoch is represented in the Upper Valley by the Honda series of Hettner (1892). The strata comprise conglomerates and medium- to coarse-grained greenish-gray and black speckled sandstones, with minor amounts of maroon to greenish-colored shale interbeds. Chert fragments are abundant in the conglomerates, and fossil wood is found in places. The series is divisible megascopically into a lower non-andesitic part and an upper andesitic division. The latter division contains pebbles of andesitic and dacitic types and is tufaceous in places near the top. The writer finds that the series is characterized as a whole by the presence of abundant amphibole and black metallics among the heavy mineral content.

The series is estimated to have a thickness of about 3,600 meters in the Honda district. The Miocene age is assumed from stratigraphic position and studies of plant remains.

The Honda series is definitely equivalent to the Real series of the Middle Valley.

The term "Honda" has been erroneously assigned to the younger Mesa formation, and the terms "Barzalosa" and "Girardot" have been applied to the Honda series itself. For reasons of priority it is preferable to retain the name "Honda series" for the strata described.

TERRACE DEPOSITS. A number of terrace deposits were formed during the erosion of the Magdalena Valley, but have not been studied as yet.

MESA FORMATION. (Pliocene or early Pleistocene?) The Mesa formation has been described in the discussion of the Middle Valley. The open country of the Upper Valley permits excellent observation of the coalescing alluvial cones that descend from the Cordillera Central to form the piedmont deposit. Adjacent fans did not develop simultaneously in every case; the Mesa beds east of Honda apparently were deposited somewhat earlier than other alluvial fans farther south.

The details of these deposits have not been worked out to date. The intersections of the various alluvial fans present local problems of structure and lithological variation that are puzzling unless the general relationships of separate coalescing alluvial fans is appreciated.

Hubach describes the Coyaima formation in the Upper Valley; it is probably equivalent to the Mesa formation.

QUARTERNARY. Numerous post-Mesa terrace deposits occur along the flanks of the valley and in tributary valleys.

A widespread younger valley filling of silt, sand and gravel, about 30 meters thick, exists throughout the Upper Valley and seems to be the correlative of the Magdalena formation of the Middle Valley.

C. W. Washburne and K. D. White briefly recorded the Lerida formation in the Honda district. This probably represents the formation underlying the plains of Mariquita, in Tolima, which was deposited after extensive erosion of the Mesa formation.

CORRELATION

Sufficient details for a final correlation between the Middle and Upper Magdalena Valley are lacking. However, it is felt that some tentative statement may be useful if it is accepted only as the product of interpretation for use as a working hypothesis to be checked by future field work. Table I is arranged to show: (1) the stratigraphic column of the Middle Valley, largely based on Wheeler's paper, with a tabulation of

characteristic lithologies; (2) a column showing a compilation of the many interpretations and applications of formational names in the Upper Valley, with a tabulation of the respective lithologies involved; (3) a suggested nomenclature largely based upon the writer's tentative correlations between the Middle and Upper Valley.

STRUCTURE

The general regional strike of folds in the Middle and Upper Valley is north 20 to 30 degrees east, parallel to the major structural lines in the Cordillera Oriental. The folds strike obliquely to the general trend of the Cordillera Central, against which they terminate. Plunging structures are common and the importance of minor fault systems varies locally.

H. Stille and, later, J. V. Harrison have emphasized the graben nature of the Magdalena Valley. J. T. Duce noted evidence that the valley is probably overthrust both from the east and west. Thrust faults of tremendous throw, some placing Miocene in contact with the upper Cretaceous Guadalupe series, exist on the east side of the valley. The west side is complex; in places a simple relationship of overlap toward the west seems to prevail, but relationships differ at various localities. The graben nature of the valley, therefore, is open to serious question which can be answered only by extensive detailed study.

Figures 2 and 3 show two east-west cross-sections, one in the region of the Cambao road from Facatativá westward some distance south of Honda, and the other in the Ibague-Gualanday region.

Strata and structures under the Mesa formation are unknown and their representation is based on interpretations.

Many fault-planes along the eastern margin of the valley may have moderately flat dips to the east, representing thrusts from that direction.

It has been widely assumed that a fault exists, buried under the Mesa formation, along the western margin of the valley in the Honda district. This assumption satisfies the hypothesis that the Magdalena Valley is a graben, but nevertheslss still requires critical investigation, as does the graben hypothesis itself, as is noted above. For that reason the existence of the fault is questioned on the interpreted geological cross-section between Santana and Facatativá (Fig. 2).

OIL HORIZONS

Majority opinion considers that the Cretaceous rocks, especially those of the Villeta series, are the source beds of commercial deposits of petroleum; F. M. Anderson believes that the exploitable oil originated in the older Tertiary ("Eocene and possibly Oligocene") sediments; and K. Ermisch considered the source beds to be in the Chuspas series, Oligocene of the Middle Valley.

The Tropical Oil Company production is reported from the La Paz formation (Middle Eocene) and from formations of Oligocene age.

Favorable reservoir beds occur in strata from the upper Cretaceous Guadalupe series upwards throughout the Tertiary, varying from place to place.

Oil seeps are well distributed from the Guadalupe series upwards. Some of special interest are also known in the granites cropping out in the eastern foothills of the Cordillera Central, in the valley of the Rio Miel in the upper part of the Middle Valley.

Evaluating a Year of Mexican Socialism

MARCH 18 marks the first anniversary of Mexico's expropriation of American and British oil properties. A look at the record shows what Mexico has accomplished during this eventful year while operating her oil industry through the new government Petroleos Mexicanos, as well as the conditions in various industries and businesses throughout the country.

PETROLEUM

The official petroleum production figures for the full year of 1938, are given as 38,505,824 bbl. compared with 46,690,000 bbl. for 1937. Approximately 12,000,000 bbl. of this 1938 production was handled by the oil companies prior to expropriation of their properties, so that under governmental control the Mexican production was about 26,000,000 bbl. since expropriation. Domestic consumption accounted for 13,500,000 bbl. of this total. Approximately 8,000,000 bbl. were exported primarily through barter arrangements with Germany and Italy. The balance, around 3,500,000 bbl., was added to storage which, at the end of 1937, amounted to 13,000,000 bbl. Present storage is estimated at somewhere between 17,000,000 and 18,000,000 bbl. Reports indicate that all available storage facilities are practically filled to capacity and that either added storage facilities must be obtained or new sales outlets created or production will have to be curtailed. Indications are that the bulk of the present production is being obtained in the prolific Poza Rica field. The North and South Fields and the Isthmus field have been shut down considerably and their total production cut to a very small portion of the current total.

Domestic consumption of petroleum products has fallen from an average of 1,750,000 bbl. per month to approximately 1,500,000 bbl. The automobile public has complained loudly about the poor quality of the gasoline which the government is manufacturing. The poor quality is due to the low octane count in the current gasoline as compared to that manufactured and sold prior to expropriation. The public in general are using their cars less and less in order to save on operating expenses, since it takes more liters with the present product to cover the same mileage as heretofore.

MARITIME TRADE

Statistics on the actual movement of vessels are not available, the actual amount of import and export trade does reflect, however, to a great extent the shrinkage of activities in the principal ports of the country.

EXCELSIOR, Mexico, D.F., writes editorially on October 28 on the subject as follows:

"There was a time when our ports in the Gulf and the Pacific presented the busy and cosmopolitan aspect which characterizes the principal ports of the world. Activity was evident in the harbors and around the wharves, and on entering the center of the coastal towns it was found that this maritime activity was reflected in commercial activity. There was noise, enthusiasm, and a collective satisfaction which can only be found in towns that have a means of livelihood and no economic or political problems.

"As an immediate consequence of this handling of ships of all nationalities, the stevedores, porters and all those with permanent employment in the wharves received good wages, and this was automatically reflected in the prosperity of local commerce and industry.

"In turn, the railroads reported increased profits from the growing traffic made possible by the abundance of cargoes in the ports. It can be said without exaggeration that the favorable economic conditions of maritime trade contributed greatly to the development of industry, of agriculture and of commerce throughout the country.

"No one can deny that the prosperity of our sea ports has almost completely

disappeared. It is sufficient to review statistics to have a fair idea of the decline of activities. The movement and animation of the ports have ceased, regular service of foreign and national ships became scarce, trade languished, the railroads suffered losses, and slowly our ports fell into their present state of prostration."

The editorial quotes further on from an address by a delegate of the Monterrey Glass Co. at the national Exporters Congress.

"How are we to intensify our foreign trade when we find that a new tax of twelve percent on exports has destroyed an important part of our products, when often the foreign ships that come to load are unable to complete cargo because of the constant labor conflicts, many of them of an inter-union nature, that delay manouvers and increase costs?

"This is, unfortunately, one of the reasons for the depression felt in our ports.

"Not once, but many times the stevedores and porters refuse to load and unload ships that come to our ports from abroad, thus seriously affecting the shipping companies and the importers.

"It is easy to understand, therefore, why our efforts to restore our exports to the volume of former years are blocked."

POWER

The production of electricity throughout Mexico has shown a marked increase during the last few years, and had reached during the early part of 1938 the limit of capacity of the existing installations. The companies have been unable to increase their current output by construction of new plants and installation of necessary equipment because they were unable to obtain new capital for this necessary expansion. Increased labor demands, strikes, and the long fought evil of stealing electric current and power had reduced their income to a point which prevented their paying interest on present bonds outstanding or dividends on stock issued; therefore they found it impossible to interest outside capital for expansion purposes.

Recently there have been serious strikes which paralyzed activities at various points, especially throughout the central states. These had a depressing effect on business since workers received less wages and the people have spent more because of inevitable price rises during strike periods.

RAILROADS

The National Railways were turned over to the Workers' Administration in May, 1938, coincident with oil expropriation. Prior to that time under private management the railroads showed a steady increase in operating income. In 1937 the operating income reached the all-time high of 147,000,000 pesos. Since the Workers' Administration has been operating the railroads, the gross income has fallen off. Reports recently issued by the railroad workers state that they have lost 20,000,000 pesos since taking over. This has more recently been denied.

There has been a series of wrecks during the past two weeks which are causing much criticism of the Workers' Administration. It is ascertained that the workers smash up rolling stock, that discipline has broken down and that seniority has become more important than competence. A committee of railroad workers recently petitioned the government to take back the railroads or provide more responsible management.

Under date of September 28, 1938, UNIVERSAL GRAFICO, Mexico City, describes the railroad situation in the following manner:

"The publication by the Federation of National Chamber of Commerce of Industry of the report on the true situation of the National Railroads has not received proper attention.

"Concern should be manifested on the part of the committee over the consummated fact of the expropriation of the National railroads, but also because they constitute a public service of first importance and because, sooner or later, the Mexican people will have to pay all pending accounts.

"The report above mentioned states that the railroads are sustaining themselves out of the capital inherited from past governments, without any amortization, (to the railroad debt). The tracks are in poor condition. Rails are worn, cross ties are rotten, locomotives are getting old and cannot be used much longer in spite of repairs being made in vain effort to rejuvenate them; there are not enough freight cars and the bridges built for operation under conditions prevailing twenty years ago cannot stand the weight of fast trains with more powerful and heavier modern locomotives.

"The outlook cannot be darker and the diagnosis is fatally one of death. Under these conditions, within ten years, the railroads will practically be out of existence. . . . the remedy is obvious. In the first place, efficient and honest management . . . The railroads are bankrupt not alone because of the excess of personnel and wages but also because of the errors inherent in the anti-economic layout and original planning."

AGRICULTURE

Latest reports on the agricultural situation as described in the Bulletin of the BANCO NACIONAL DE MEXICO state that:

"The harvest has been disappointing both to farmers and to everyone who was depending on it to expand operations. The information we have is vague and incomplete, but it is enough to be able to predict that the coming year will not be one of plenty but one of scarcity of grain and other farm products; that high prices will continue, and consequently, the crisis will continue because, as we have explained before, it is due to the inability of the people to buy industrial goods because they either lack the means or too large a percentage of their income is used to purchase food. This condition prevents industry from operating at a reasonable activity to the decided detriment of the workers and of consumption itself . . .

"It appears that crops will be smaller than they were last year. A portion of this decrease is due to the fact that the new land owners do not have the means to work the land properly that was distributed to them. Due to this lack of resources farmers are forced to plant only what is absolutely necessary to satisfy their most pressing personal needs and do not produce the surpluses for sale to the outside market which would provide them with cash for clothing and other nesessities required by the new and higher standard of living.

"Funds are not available in amounts sufficient to achieve these objectives, nor are appropriate methods used. While land distribution has been speeded up to terminate a similar program that had previously been followed for twenty years, no credit structure has been created."

The BULLETIN states further that:

"In one of the principal newspapers in Mexico City we read the following wire report: 'Guanajuato, November 10, 1938. In recent weeks the Arbitration and Conciliation Board in the Capital of this State has seen its activities doubled by the number of requests for labor adjustments made by companies that claimed to be unable to make profits. The situation unquestionably reflects the crop losses in practically all the states in which the land formerly was fruitful and which has now been placed in the hands of agitators who, instead of dedicating themselves to working the lands given to them, spend their time demanding wage increases that are out of proportion and which hinder the development of agriculture."

Poor crops of corn, wheat and beans—prime essentials in the life of the Mexican masses—necessitated the importation of tremendous quantities of these commodities compared to previous years. As pointed out in the United States Department of Commerce reports, Mexico imported 877,825 bushels of corn in the first eight months of 1938 as against only 27,881 bushels during the whole year of 1937. Only 10,000 bushels of wheat were needed for the first eight months of 1937, while 2,275,000 bushels were required for the same period of 1938. Up to September, 1938, importations from the United States reached a total of 669,000 pounds of beans. The importation of "red kidney" beans has reached a total of 7,694,000 pounds from Japan and the United States. Mexico in former years usually raised sufficient quantities of these commodities to supply her own needs and in many instances had a balance for export.

Consumer buying power, apart from the hardships upon consumers imposed by constantly advancing food prices, showed

the effect of the general unsettled financial situation brought about by the fall of the peso in relation to the dollar during the past year. While Mexican goods were lower in price in world markets, the reverse was true of all products imported from the outside, particularly those from the United States. The fall-off in sales volume in various industries is more readily seen when comparison is made of the figures given in the U.S. Department of Commerce report. Comparison for the first eight months of 1937 with the same period of 1938 is shown in the following table:

Mexican Imports	8 Months 1937	8 Months 1938
Grease proof, waterproof and wrapping paper	Lbs. 6,046,000	Lbs. 670,000
Box board	14,570,000	5,486,000
Paraffin wax	6,002,000	3,860,000
	Long Tons	Long Tons
Iron and steel scrap	33,316	14,336
Steel ingots, blooms, etc.	11,991	95
Other metal products such as tin plate, wire, tubular products, car wheels, etc.	$7,393,000.	$3,068,000.
	Units	Units
Stoves and furnaces	23,093	7,744
Sewing machines	15,211	1,379
*Typewriters	13,049	2,435
*(The total in 1937 was 18,947)		
Railway cars	975	468
Household refrigerators	5,902	1,272
Radio sets	62,755	13,432
(The total in 1937 was 93,634.)		
Automobile trucks	5,201	1,246
Automobile passenger cars	6,048	1,793

In line with the above figures, Mexican retail trade is complaining of two things, as mentioned in the December report of the Banco Nacional de Mexico:

First: the decrease in sales compared to a year ago; second, the preference of the public for purchasing cheap goods instead of more expensive ones. They believe that both factors are clear indications of the weakness of the purchasing power of the consumer. In spite of the fact that wages are higher; that salaries of office workers have increased; and that government wages have not declined, there seem to be more difficulties encountered in selling high class merchandise, due to the rise in the cost of foodstuffs. It is also due to the fact that such merchandise has gone up in price through the depreciation of the peso, as a great deal of the goods in this class are imported. But the main cause is the high cost of foodstuffs, which means that the average wage earner is compelled to spend most of his cash for the bare necessities of life, and has small surplus for even modest luxuries.

According to the figures published by the Chamber of Commerce, from October to November the following articles have gone up in price; broken rice two centavos a kilo, coffee 20, 15 and 7 centavos on the three main qualities used; peppers 7, 10 and 22 centavos; red beans 20 pesos a ton; co'ored beans 30 pesos a ton; black beans 20 pesos; fava beans 3 centavos a kilo; flour 25 centavos a bag; corn from tropical regions 4 pesos a load; corn from cold regions 10 pesos a load; lard 3 centavos a kilo; potatoes 3 centavos a kilo.

No considerable importations of automobiles have been made and sales of new autos are below what they formerly were. Many people prefer buying second hand cars, keeping their old ones in use because of the high prices of the new models. For this reason the consumption of tires and inner tubes is greater. Furthermore, at this time of the year, there is a seasonal improvement in this line.

Shoe manufacturers have noticed a decline in the quality consumers are buying. The lack of funds on the part of the people forces them to buy the cheapest make and this is one of the problems of the industry. The factories that manufacture only expensive shoes have seen their sales cut in half.

EL MUNDO, Tampico, on October 27, in an editorial entitled "How the Happiness of the Mexican people has been achieved," states:

"As a consequence of the increased cost of living estimated at an average of 30 percent in relation to prices during the first months of the year, the majority of the inhabitants of Mexico have cut down their expenses to the most indispensable needs, so that the greatest number are able only to provide for food for themselves and their families and have to dispense with new clothes and shoes, prolonging to an impossible point the life of their old clothing.

"This is the case in Mexico since the government undertook the task of changing the economic structure of certain important industries such as oil, cotton, and henequen.

"The Mexican people, brought to the most extreme poverty by the fatal leftist policies of the government, give preferential attention to food and as far as possible go without buying clothing, shoes, and other things that are not absolutely essential.

"As a proof of this assertion, we offer the data contained in the 'Review of the Economic Situation of Mexico,' published by the Banco Nacional de Mexico, for the month of October. In the section regarding the conditions of industry, and referring particularly to the industries that affect clothing, it says: 'Up to August 31 the cotton textile mills continued to increase their stock of manufactured goods despite the fact that some of the mills have been able to reduce their working period to four, four and a half and five days a week, since piece-work in many instances compensates the reduction of the working period. The sales of these mills have increased but little, and current prices are the same as before the crisis, so that, taking present conditions into account, there are no profits, only losses.'

" 'The wool industry is working four and a half, five, and six days a week and the mills are desirous of arriving at an agreement to restrict production adequately to meet consumption demands, since the former now exceeds the latter. The demand for cassimere has not increased and the woolen mills are quiet. The price situation for these articles is the same as for cotton goods. The rayon industry is in like circumstances: disorganized, exposed to ruinous competition and hoping for an opportunity for reorganization.' "

FINANCE

The Bank of Mexico published about the first of March, 1939, the official figures for 1938, showing a favorable trade balance for Mexico of 344,803,000 pesos. While this trade balance for excess of exports over imports is true, it is not quite as favorable when compared with the same figures for the year 1937. In 1937 exports amounted to 892,300,000 pesos, or 52,200,000 pesos more than in 1938, while imports showed a drop of 120,300,000 pesos from 613,700,000 down to 493,400,000 pesos. The same report said that while the price index in the United States decreased from 80.9 in the last quarter of 1937 to 73 in the last quarter of 1938, the price index for Mexican articles rose from 121 to 127.7 in the same period. This difference in domestic and foreign prices was a grave phenomenon which affected the trade balance. Relative to the actual amount of monetary reserves, the report said that between December 31, 1937, and March 18, 1938, the value of reserves was reduced from 108,400,000 pesos, which then represented $30,000,000 U.S., to 102,200,000 pesos, then worth $28,400,000 U.S. At the close of 1938 the reserve was said to have increased to 119,500,000 pesos, or $30,200,000 U.S., but by virtue of the decrease of December 28, 1938, the reserve was increased by $5,000,000 U.S. by the revaluing of silver and by 31,300,000 pesos by the revaluing of gold and other foreign monies in reserve, through which it reached 175,900,000 pesos. The report, discussing the overdraft of the government with the Bank of Mexico set the amount at 146,900,000 pesos, plus 27,800,000 pesos in road bonds at the end of November 1938. By virtue of the decree of December 28, 1938, according to the report, 33,200,000 pesos was credited to the government account, representing the revaluation of gold, silver and foreign currencies held in the Bank, thus giving the government gains obtained by devaluation.

Financial experts said that while the figures published in the report were exact and the balance of trade in favor of Mexico is excellent, the sacrifice of the metallic reserves and the depreciation of the currency caused an unhealthy economic situation. It is asserted that in the comparisons of trade balances of 1937 and 1938 the difference in the value of the peso in relation to the dollar was not taken into account, and, consequently, the figures on international commerce were inflated.

The Mexican government minted over 11,000,000 ounces of silver in 1938, of which

(Continued on page 122)

Night view of Richfield's new Watson refinery.

RICHFIELD'S New $5,000,000 Refinery is Result of Sound Cooperative Engineering

ONE OF THE FIRST and most pressing problems facing Richfield Oil Corporation when it was reorganized in March, 1937, (consolidating the assets and properties of Richfield Oil Company of California, Pan American Petroleum Company and Rio Grande Oil Company) was the modernization of its refining facilities. It had plants at Watson, Hynes, and Vinvale, but it was uneconomic to operate three refineries in one area, while none of the installations contained sufficient modern equipment to take care of the new company's requirements.

In reorganization, an agreement had been made whereby Richfield could call on Sinclair Refining Company for engineering services. Sinclair's development department studied the situation and rejected the rehabilitation and operation of existing equipment as economically and technically unsound. After careful consideration of the report Richfield decided to concentrate operations at Watson, keeping Vinvale intact for use if and when required, and an expenditure of $5,000,000 was authorized.

In July, 1937, major contracts were awarded. C. F. Braun and Company received orders for construction of two combination crude distillation and cracking units, a debutanizer, a stabilizer, a hydrogen sulphide removal plant, a polymerization plant, and a caustic wash unit. Other work let to Braun included the revamping of an existing crude battery and the rehabilitation of the electrical and water systems. The Bechtel-McCone-Parsons Company was awarded the contract for rebuilding the gasoline rerun unit.

One of the most impressive features of the new unit is the fundamental soundness of its engineering. This is a distinct tribute to the close cooperation between Sinclair's engineering staff representing Richfield, and the contractor's engineering organizations.

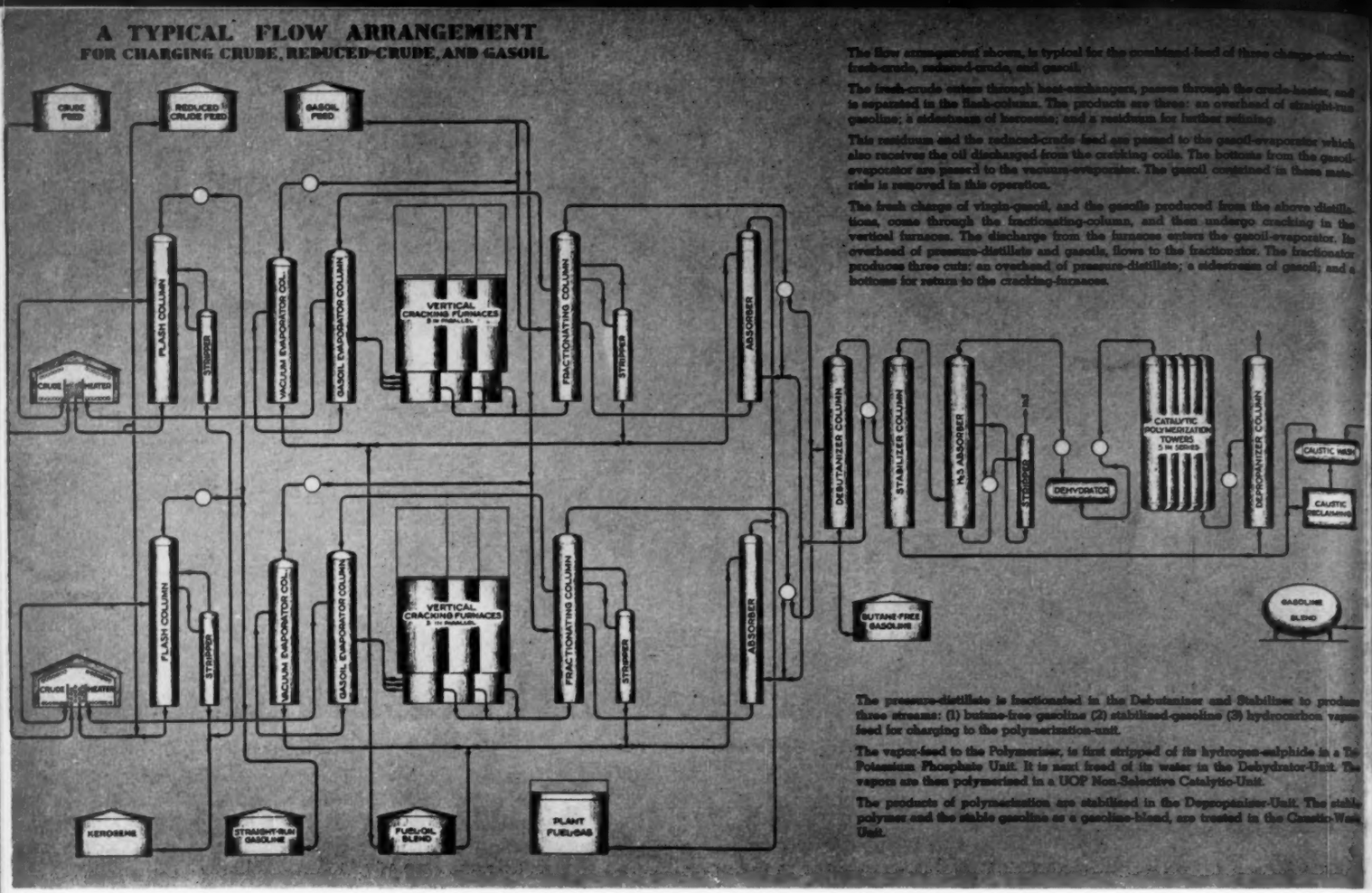
The site was cleared in August, and building began in September, 1937.

In a construction program of this size it is extremely important to keep material and equipment moving in as required. This is difficult enough under the best circumstances but this job was further complicated by the heavy rains and resultant floods of the spring of 1938. The large equipment constituted a major transportation problem. Seven evaporating and fractionating towers were required for each of the two combination units. The two main bubble towers are 13 ft. in diameter by 60 ft. high and weigh 250,000 lb. each. Transporting these towers necessitated one way traffic over the railroad, as they would not clear passing cars on adjacent tracks when loaded on flat cars. With these handicaps, the job moved slowly during the early spring and it appeared that the completion date of August, 1938, would be difficult to meet.

In July, 1938, the rebuilt crude and rerun units were finished and turned over to the operators, who successfully put them into operation during the first part of the month.

The first of the two combination units, known as number 81 Still, was not ready to operate on August 1st, but the equipment was given hydrostatic tests that week. These tests showed no leaks so the unit was put on cold oil recirculation. During this period all pumps were run in, leaky valves repacked, control equipment adjusted, and careful inspection made of all mechanical equipment. This in itself was no small job; there were 50 pumps, over 100 major valves, and some 40 mi. of piping to be checked and tested.

The battery of heaters was fired, for drying out purposes, during the recirculation period and on August 19th firing for operation was commenced. It is axiomatic in the refining industry that a certain amount of trouble will be encountered in bringing a big combination unit on stream for the first time but 81 Still came up to operating conditions without a hitch. By midnight of August 20th finished gasoline was going into the tanks. By morning, the starting up crew who had been on the job


A TYPICAL FLOW ARRANGEMENT
FOR CHARGING CRUDE, REDUCED-CRUDE, AND GASOIL
The flow arrangement shown, is typical for the combined-feed of three charge-stocks: fresh-crude, reduced-crude, and gasoil.
The fresh-crude enters through heat-exchangers, passes through the crude-heater, and is separated in the flash-column. The products are three: an overhead of straight-run gasoline; a sidestream of kerosene; and a residuum for further refining.
This residuum and the reduced-crude feed are passed to the gasoil-evaporator which also receives the oil discharged from the cracking coils. The bottoms from the gasoil-evaporator are passed to the vacuum-evaporator. The gasoil contained in these materials is removed in this operation.
The fresh charge of virgin-gasoil, and the gasoils produced from the above distillations, come through the fractionating-column, and then undergo cracking in the vertical furnaces. The discharge from the furnaces enters the gasoil-evaporator. Its overhead of pressure-distillate and gasoils, flows to the fractionator. The fractionator produces three cuts: an overhead of pressure-distillate; a sidestream of gasoil; and a bottoms for return to the cracking-furnaces.
CRUDE FEED
REDUCED CRUDE FEED
GASOIL FEED
FLASH COLUMN
STRIPPER
VACUUM EVAPORATOR COL.
GASOIL EVAPORATOR COLUMN
VERTICAL CRACKING FURNACES
FRACTIONATING COLUMN
STRIPPER
ABSORBER
CRUDE HEATER
DEBUTANIZER COLUMN
STABILIZER COLUMN
H2S ABSORBER
STRIPPER
DEHYDRATOR
CATALYTIC POLYMERIZATION TOWERS
DEPROPANIZER COLUMN
CAUSTIC WASH
CAUSTIC RECLAIMING
BUTANE-FREE GASOLINE
GASOLINE BLEND
KEROSENE
STRAIGHT-RUN GASOLINE
FUEL OIL BLEND
PLANT FUEL GAS
The pressure-distillate is fractionated in the Debutanizer and Stabilizer to produce three streams: (1) butane-free gasoline (2) stabilized-gasoline (3) hydrocarbon vapor feed for charging to the polymerization-unit.
The vapor-feed to the Polymerizer, is first stripped of its hydrogen-sulphide in a Di-Potassium Phosphate Unit. It is next freed of its water in the Dehydrator-Unit. The vapors are then polymerized in a UOP Non-Selective Catalytic-Unit.
The products of polymerization are stabilized in the Depropanizer-Unit. The stable polymer and the stable gasoline as a gasoline-blend, are treated in the Caustic-Wash Unit.

Flow arrangement for charging crude, reduced-crude, and gas oil.

continuously for over 24 hours turned the job over to the regular operators. A day later the big still was turning out products in excess of the original design and running smoothly.

With 81 running regularly and smoothly, 82 Still, the second of the two combination units, was put on stream on September 9th. The big unit went right to work and put out more products than original design called for. Both stills were kept on the line for 30 days and then brought down for routine inspection. The fact that two units of this size started up and produced designated products without requiring any shut-downs due to erroneous design, poor workmanship, or faulty operation is a considerable achievement. It was not due to luck but to sound engineering design, excellent construction, careful inspection, thorough training of the operators, and complete cooperation between the staffs of Richfield, Sinclair, and Braun.

DESCRIPTION

The main extension to the Watson refinery was set up as two identical combination crude topping-cracking units having a common pump house and control room centralizing control and simplifying tie-in with the balance of the refinery.

The plant is built for running a wide variety of California crudes with sufficient flexibility to handle extraneous reduced crude from the rebuilt topping units. Each unit can charge 25,000 bbl. per day, the variations in the charging stock ranging from 20,000 bbl. crude plus 5,000 bbl. reduced crude, to 10,000 bbl. crude and 15,000 bbl. reduced.

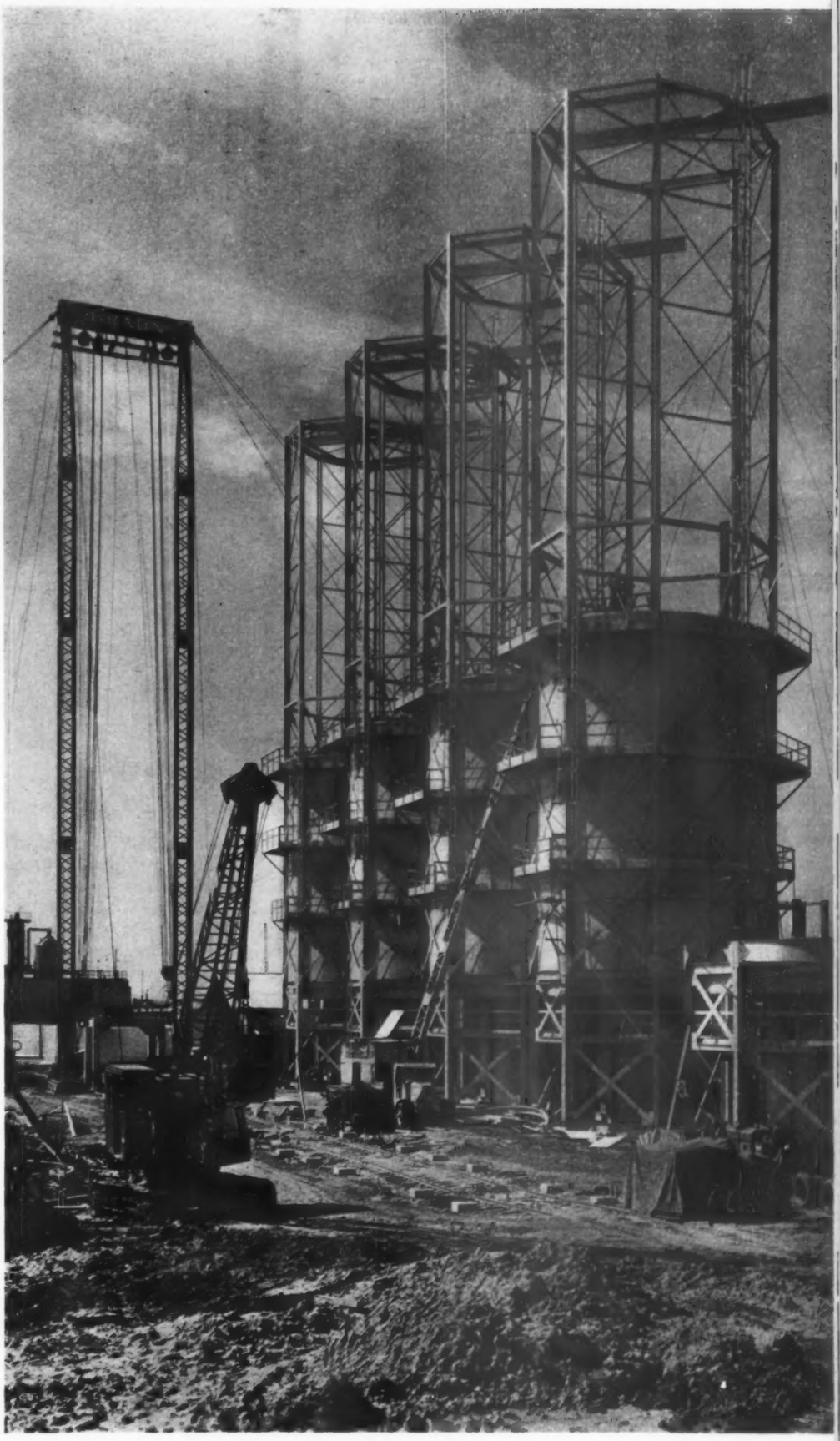
Flow of the operation is as follows: crude charging pumps, discharge at 300 lb. through automatic flow controller to exchange, heat being furnished by circulation of upper side streams from the main fractionating column. This preheat is to 300 deg. F. from whence the oil flows into a salt settler where back pressure of 250 lb. suppresses vaporization. The crude flows to exchange against tar evaporator overhead vapors and circulating heat medium from the bottom of the main fractionating column, thence to one section of the feed heater. With clean exchange, firing of this side of the heater is light, approximating 15,000,000 BTUs per hour, with a potential of 35,000,000 BTUs, leaving considerable leeway for dirty exchange or any variation in required flash temperatures. With a pressure drop of approximately 60 lb., no difficulty is experienced with flow through the parallel paths.

Discharge from the heater is directly to the crude flash tower which fractionates the crude into 350-400 deg. F. end point overhead, a kerosene distillate side stream which is steam stripped, and reduced crude bottoms testing approximately 15-18 gravity. Reduced crude bottoms serve as the main feed stock to the cracking cycle. Suction is taken on the bottom of the crude flash tower by centrifugal pump at 300 lb. through tar exchange and thence to the other half of the feed heater where the material is preheated to $\pm$700 deg. F. and discharged into the cracking cycle. The residue from the cracking cycle is flashed in the vacuum evaporator under reduced pressures. The asphalt bottoms produced are released through exchangers against reduced crude. They are blended with the cracked recycle gas oil and thence through the tar coolers to tankage. By control of this operation a wide range of specifications can be met, low in B.S.&W. and sediment, and stable when blended to low viscosities.

The condensed overhead from the vacuum evaporator is discharged directly to the bubble tower and furnishes the main part of the heater flow. Level in the main fractionator of the cracking cycle is maintained by extraneous gas oil feed which can be a part of the vacuum evaporator overhead previously released to tank or extraneous gas oil from lube or other operations.

(Continued on page 109)

Richfield's Watson refinery was erected in a comparatively short time despite the many obstacles.



The heater feed is picked up from the bottom of the fractionator and discharged through three DeFlorez down-fired heaters, preheated to cracking temperatures and released into a common transfer line, discharging back into the cracking towers. The main fractionator removes a 400 deg. F. end point cracked distillate as an overhead product, and a stripped recycle gas oil side stream which is used in part to blend with fuel, in part cooled for circulation over the absorber and the balance is removed to tankage.

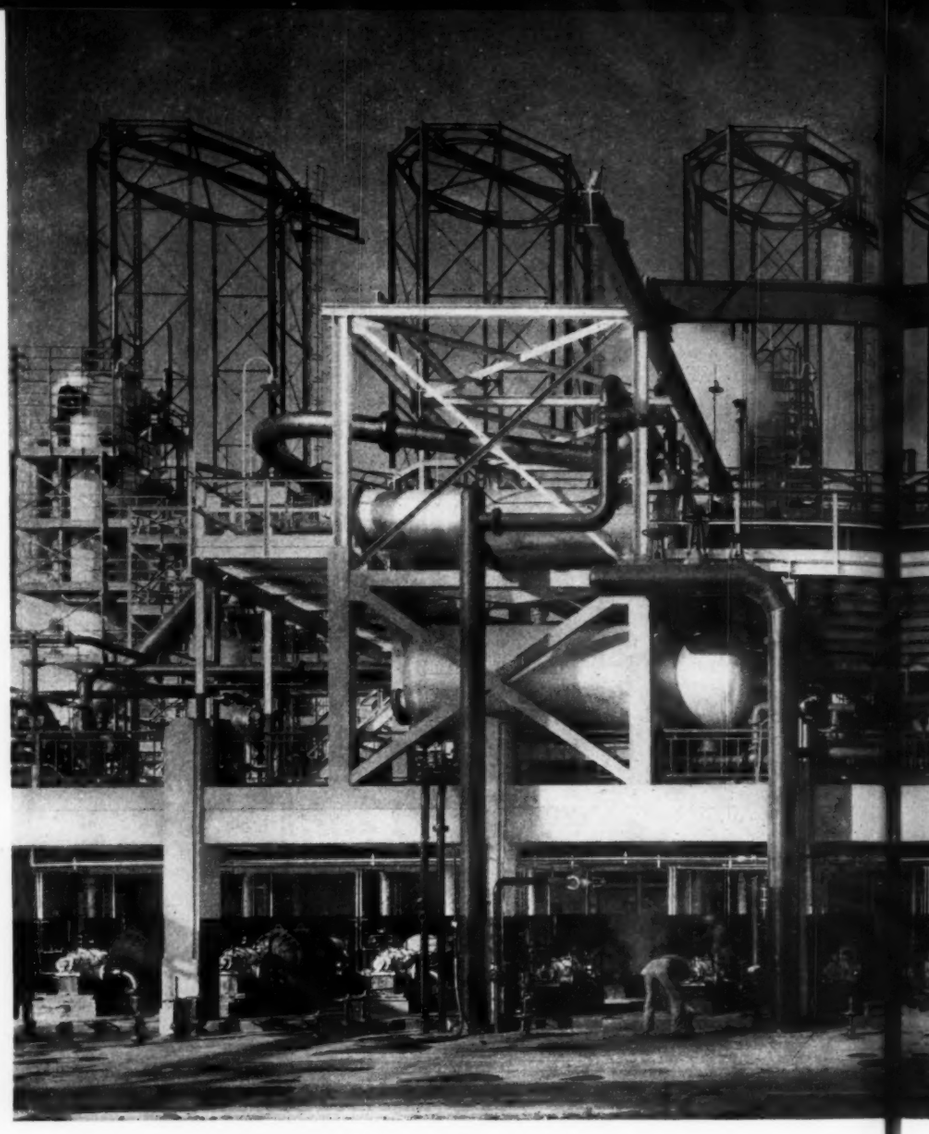
The unit is well laid out, the overhead cracked distillate flows down through submerged condenser sections located on the roof of the control room, and thence through aftercoolers into receiving drums which are located on the deck of the control room floor. Gas is released from the receiving drums into individual absorbers with the distillate flowing through overhead lines direct to the debutanizer feed drums located at ground level. Reflux pumps located immediately below the receiving drum deck take overhead suction on the receiving drums and discharge back through the control manifold located on the still side of the control deck, and thence to the top of the bubble towers. Other products, similarly, assume this natural flow.

The essential control of the units is automatic, having the latest instrumentation in level, temperature, flow, and other automatic devices. All instruments are placed in the central control room which is located to give ready access to all parts of the unit by interconnecting walks and stairways. A Philco-phone system is installed to give ready communication throughout the unit.

All of the main flows are discharged to a centralized manifold where the automatic valves are housed from weather, and which is so located in proximity to the control room that hand control can be resorted to should any instrument be out of order.

The pumps are mostly motor driven centrifugals with centrifugal steam driven standbys, the standby pumps being common to both stills. The pump rooms are equipped with facilities for quick changing to the spare should the pump fail. Also the crude and reduced crude feed pumps are equipped with tandem steam driven turbines, in addition to their common steam standby, which automatically cut in in case of power failure.

To meet corrosion, chrome-moly alloy has been used liberally throughout the plant. All piping subject to corrosion is protected with weep holes, thus offering an immediate tell-tale in case of severe wear or corrosion.



Combination unit receiving house, looking north, after completion.

Approximately 33 percent of the total heat required is supplied by exchange. Efficiency of the DeFlorez heaters, approaching 80 percent, in addition to the waste heat exchange, gives extremely low over-all fuel figures. Recent tests show as low as 200,000 BTUs per bbl. of feed.

The 400 deg. F. end point distillate yields range from 32 percent to 40 percent depending upon the gravity of the reduced crude charged to the cracking cycle and viscosity of the fuel produced. Fuel viscosities range from 90 vis at 122 SF to 150 SF maximum. Conversion rates on the DeFlorez heaters, approaching 20 percent crack per pass, have been realized with no coking of the heaters.

Typical Yields on Type Reduced Crudes

Type of Reduced Crude:	Ventura Reduced Crude	Wilmington Reduced Crude
400 E.P. Cracked Distillate	38.5	35.1
Dry Gas (fuel Equiv. @ 1300 BTU)	4.5	4.2
Cracked Tar	61.5	65.7
Vis at 122 S. F.	135	100

Runs to date have been shut down on 30 day cycles for inspection. As soon as corrosion rates have been established, longer runs will be in order—90 day runs being entirely feasible. Although the units are essentially designed for heavy oils, flexibility in equipment can quite readily accommodate cracking of light distillates or reforming of naphthas.

POLYMERIZATION

In addition to the two combination units, the Richfield program included cracked distillate finishing units. Such units provide for the debutanization of the raw distillate for the purpose of producing a bottoms product most adaptable for subsequent treating; the stabilization of the light ends of the pressure distillate to furnish poly charging stock consisting of butanes and lighter; the polymerization of such gaseous hydrocarbons into poly gasoline; and the caustic washing of all stabilized light ends for mercaptan sulphur removal.

The raw cracked distillate as produced on the combination units includes all desirable light ends and it has an A.S.T.M. end point of 400 deg. F. This distillate is fed directly to the debutanizer unit, which operates at about 100 lb. gauge pressure.

The debutanizer is of the conventional type. By flow, temperature, and pressure controlled distillation and fractionation a bottoms product having an A.S.T.M. initial boiling point of about 225 deg. F., is produced. This bottoms product is routed through treating and rerun operations for finished gasoline conditioning.

The debutanizer liquid overhead, which contains all of the butanes and lighter from the cracking operation, is fed to the stabilizer operating at 200 lb. gauge pressure. Distillation and fractionation, obtained by careful flow, temperature, and pressure control is carried on to produce a butane free bottoms product (casinghead) and a gaseous overhead which contains all of the butylenes and propylenes. Heat required is furnished by a circulating heat medium from combination unit source, and from high pressure steam.

The stabilizer release gas, because of its hydrogen sulphide content (five percent), must be processed in a gas treating system before it passes on to poly plant to avoid production of poly gasoline high in fixed sulphur content. The tri-potassium phosphate process is used for this purpose and removes over 90 percent of the hydrogen sulphide present.

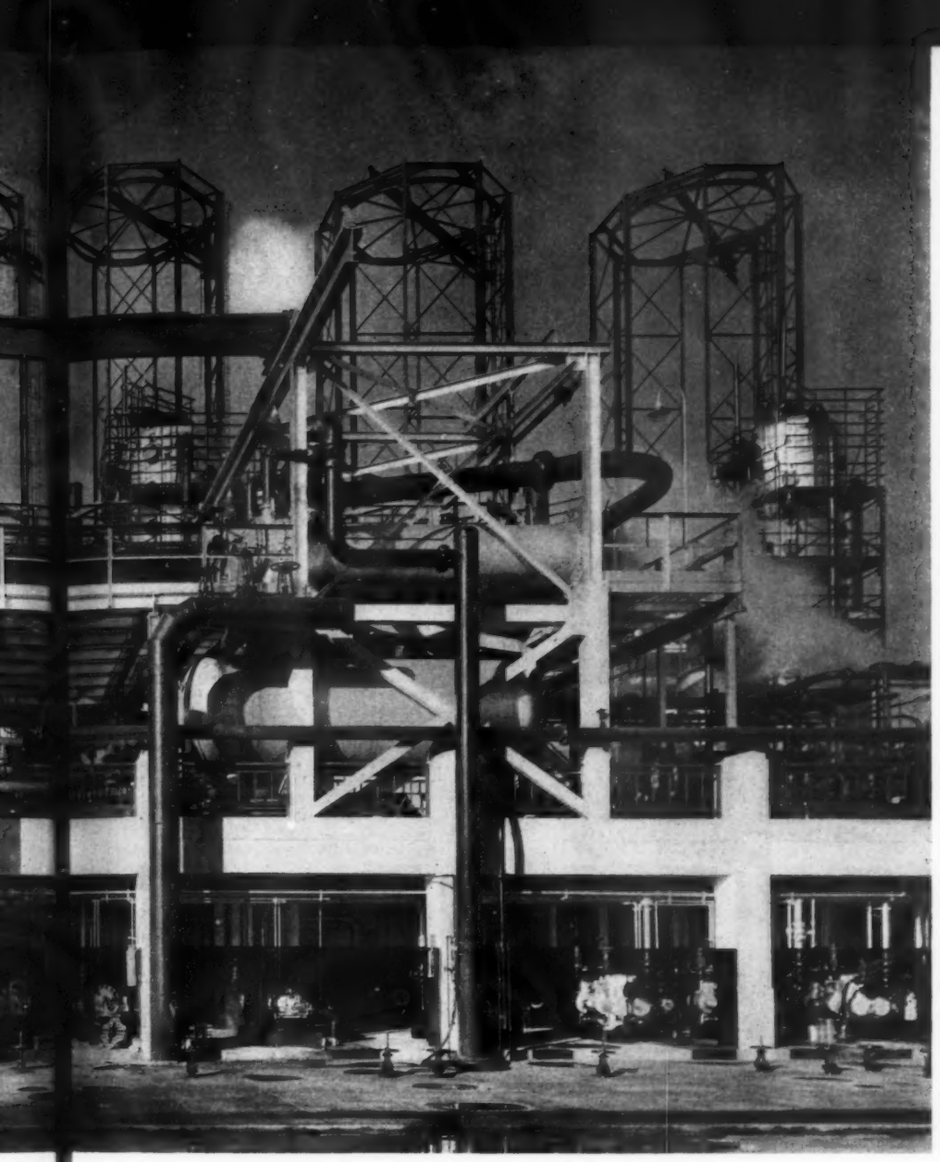
The gas treating plant was fabricated from plans based on flow diagrams furnished by the Shell Development Company and the process used is licensed under patents assigned to the Shell Development Company.

Feed to the plant is composed of a mixture of paraffines and olefines up to and including butanes contained in the overhead from the gasoline stabilizer unit. Substantially all available butene is contained in the gas. From the hydrogen sulphide removal unit the gases pass to a catalytic polymerization plant. The treat was designed to reduce 3,500,000 standard cu. ft. per day from an initial content of 3,000 grains per 100 cu. ft. to 100 grains per 100 cu. ft. Operating temperature and pressure assumed for design were 185 deg. F. and 200 lb. gauge, respectively.

Absorption is accomplished principally according to the reaction:

$$K_3PO_4 + H_2S \longrightarrow K_2HPO_4 + KHS$$

The reaction is reversed during regeneration. Mercaptans are not removed by the phosphate process. Ammonia, when present, is absorbed by the solution and is driven off along with the hydrogen sulphide. Gases enter the absorber at the bottom, rise through 36 bubble plates countercurrent to a stream of descending absorbent solution, and pass out at the top. The absorbent is tripotassium phosphate solution containing 2.0 gram mols K_3PO_4 per kilogram



of solution. It was mixed at the site from steam condensate and commercial grades of potassium hydroxide and phosphoric acid in such proportion that the mol ratio of KOH to H_3PO_4 was between 2.95 and 3.00 to one. From the absorber the foul solution is released by level control to the regenerator. Regeneration is accomplished by concentrating the solution in a standard steam heated boiler. The concentrated solution falls to a surge tank where residence at the boiling temperature causes further regeneration. The regenerated solution is pumped back to the absorber by way of the heat exchangers and a solution cooler. Vapors, hydrogen sulphide and steam, pass overhead from the reboiler to a condensate stripper which is a small two-plate bubble column surmounted by a condenser and a phase separator from which water is refluxed to the stripper. H_2S goes overhead to a waste products burner. Stripped condensate is returned to the top of the absorber.

This plant utilizes one interesting feature of the phosphate system. The equilibrium solution saturation, expressed as mols H_2S per mol K_3PO_4, corresponding to a given concentration of H_2S in the hydrocarbon, is greater for a dilute solution than for a more concentrated one. Advantage is taken of this fact by doing the bulk of the stripping with a concentrated solution in the lower section of the absorber and using a dilute solution to remove the last traces of H_2S in the upper section. The dilute solution is made up of all the condensate and a portion of the regenerated K_3PO_4.

The treated gas is passed through a dehydrator to prevent phosphate solution carryover to the poly plant catalyst towers.

The hydrocarbon release gas from the H_2S unit dehydrator, containing approximately 35 percent higher olefins, now passes into the catalytic polymerization equipment where the propylenes and butylenes in the gas are converted to polymer gasoline.

The plant was placed on stream early in October. Operation has been uneventful except on one occasion. The difficulty was overcome by a slight modification of the flow plan. Suspended material, principally iron sulphide formed from mill scale, accumulated in the solution during early operation. However, when the solution was withdrawn and the plant flushed with hot water after ten weeks of operation, there was no noticeable corrosion in any part of the plant.

A typical daily operating statement appears with this article. Were the cost of steam generation a matter of primary importance, steam consumption could be reduced about one-third by stripping the solution with open steam.

Richfield Oil Corporation H_2S Plant—Daily Report

Refinery: Watson 24 hrs. Ending 7 A.M. 12-27-38

Gas Rate—Std. Cu. Ft./Day	3,060,261
Inlet H_2S—Grains/100 cu. Ft.	2,150 (a)
Outlet H_2S—Grains/100 cu. Ft.	186 (a)
H_2S Removal—%	91.5
Lbs/Day	8591
Steam	
To Concentrator, #/Day	91,550
To Surge Tank, #/Day	....
Total, #/Day	91,550
Lbs/Lb. H_2S Removal	10.7
Strong Solution, Gal./Day	57,600
Gal/1000 cu. ft.	18.8
°Be'	49.5
Foul Solution, °Be'	46.0
Weak Solution	
Strong Sol. Gal/Day	3,499
Cond., Gal/Day	7,200
Weak Sol., Gal/Day	10,699
Gal/1000 cu. ft.	3.5
Be'	19.7

Average Operating Conditions

	Temp. °F.	Press.
Gas to absorber	149	....
Absorber Top	182	....
Bott.	169	169#
Strong Sol.	183	....
Weak Sol.	200	....
Concentrate	242	....
Surge Tank	240	½#
Accumulator Top (H_2S Rec)	88	....
Bott.	212	....

(a) Includes mercaptans.

Equipment used for polymerization and stabilization consists of a process heater, five catalyst towers, water separator, raw poly condenser and receiver, and polymer stabilizer equipment.

Equipment used for reactivation of the catalyst includes a flue gas generator, flue gas scrubber, and superheater for both the flue gas during burning of the catalyst and for steam during the hydration of the catalyst.

The polymerization of cracked gas employs process heater outlet temperatures ranging from 350 deg. to 425 deg. F., maximum catalyst temperature of 500 deg. F., and operating pressures ranging from 160 to 200 lb. gauge. The products of polymerization are processed in a stabilizer operating at 200 lb. gauge pressure. The overhead is released into the refinery fuel system.

Each of the catalyst towers is periodically reactivated by first passing flue gas obtained by perfect combustion at 30 lb. gauge pressure, dehydrated by cooling and preheated to 700 deg. F., through the catalyst together with carefully controlled small successive increments of air for removal of carbonaceous matter by burning. When this operation is complete, superheated steam is passed through the catalyst bed for the purpose of conditioning the catalyst properly with respect to moisture.

(Continued on page 114)

WORLD OIL

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified

U. S. BARRELS

	February 1938	March 1938	April 1938	May 1938	June 1938	July 1938	August 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Preliminary Figures Jan. 1939
United States	94,662,000	106,524,000	102,702,000	98,674,000	94,277,000	102,898,000	106,165,000	98,661,000	101,830,000	98,567,000	102,287,000	**102,490,000**
Soviet Union[4]	13,591,000	15,984,000	17,850,000	17,580,000	18,540,000	18,200,000	17,600,000	17,500,000	17,400,000	17,250,000	17,050,000	**17,000,000**
Venezuela	13,792,479	15,109,040	13,696,219	15,994,400	16,302,150	14,912,555	16,616,673	16,271,096	17,352,171	16,356,204	16,744,163	**16,600,000**
Iran[5]	6,414,470	8,284,215	7,090,486	6,975,256	5,792,228	5,338,990	5,861,366	5,676,998	7,136,578	7,221,080	6,400,000[1]	**7,100,000**
Netherland India: Sumatra	2,587,988	2,912,764	2,809,415	2,971,443	2,893,856	2,814,237	2,901,321	2,917,167	3,049,196	3,015,432	3,177,589	**3,129,007**
Borneo	1,008,290	1,114,431	1,056,224	1,066,281	1,013,163	1,061,980	970,690	1,069,872	1,123,102	1,090,009	1,114,535	**1,115,570**
Java[9]	590,763	643,568	639,582	674,927	616,845	585,086	524,384	482,417	523,623	515,160	529,658	**535,297**
Ceram	48,388	50,377	52,329	51,524	49,870	54,035	54,825	50,355	50,444	45,750	45,773	**49,200**
Roumania	3,751,692	4,182,000	4,090,000	4,169,000	4,015,000	4,115,000	4,075,736	3,915,029	4,028,750	3,847,324	3,969,300	**3,934,338**
Mexico	2,016,000*	1,226,368*	1,912,493*	2,301,995*	2,374,815*	2,000,000[1]	3,895,453*	3,250,000[1]	3,500,000[1]	3,275,000[1]	2,950,000[1]	**2,470,000**
Iraq	2,385,464	2,717,278	2,592,996	2,332,746	2,653,579	2,806,903	2,829,528	2,621,547	2,431,949	2,420,143	2,290,777	**2,414,878**
Colombia	1,508,487	1,841,882	1,642,195	1,819,689	1,826,136	1,826,848	1,870,013	1,797,158	1,891,825	1,863,838	1,908,879	**1,688,000**
Trinidad	1,304,819	1,438,436	1,418,825	1,481,285	1,431,476	1,500,171	1,505,959	1,514,893	1,594,480	1,503,489	1,664,322	**1,652,412**
Argentina[1]	1,289,000	1,380,000	1,349,000	1,382,000	1,346,000	1,349,000	1,360,000	1,358,000	1,360,000	1,358,000	2,028,000	**2,000,000**
Peru[3]	1,224,437	1,474,364	1,296,090	1,343,259	1,303,536	1,335,623	1,328,143	1,280,691	1,331,111	1,303,990	1,321,883	**1,251,162**
Bahrein[6]	707,379	737,164	692,403	620,746	661,602	699,176	713,149	714,349	708,962	613,281	623,907	**647,988**
Burma[7]	496,306	633,644	635,903	667,346	679,368	638,000[1]	635,000[1]	650,000[1]	635,000[1]	650,000[1]	635,000[1]	**650,000**
Canada[8]	413,158	480,803	464,316	566,086	537,654	693,332	817,706	886,111	685,088	445,514	489,303	**531,364**
Brunei[9]	381,052	445,194	428,829	445,505	425,184	453,393	448,219	478,080	477,459	484,207	510,500	**506,467**
Great Germany: Old Reich[14]	257,967	355,684	342,387	329,688	326,842	346,435	342,484	328,098	331,792	307,433	313,206	**448,510**
Ostmark[15]	28,160	30,070	29,100	32,845	30,000[1]	31,062	29,453	26,772	43,697	29,000[1]	34,259	**33,609**
Slovakia	10,437	12,158	10,731	10,960	10,159	9,333	11,015	10,933	13,747	10,502	11,000[1]	**11,000**
Poland	293,232	327,077	315,768	324,803	315,381	314,000[1]	329,115	321,134	330,412	318,000[1]	326,000[1]	**326,000**
Japan[10]	214,191	214,820	207,522	216,078	216,707	216,707	217,525	170,597	220,451	224,255	173,737	**224,885**
British India[11]	132,164	197,792	196,543	198,872	192,656	195,000[1]	200,000[1]	197,800[1]	195,000[1]	198,000[1]	195,000[1]	**195,000**
Ecuador	171,138	191,746	181,331	190,542	188,712	192,360	193,634	189,037	192,702	185,669	192,882	**195,556**
Saudi Arabia	4,155	2,622	2,382	3,794	3,477	3,550	3,459	40,556	136,947	152,632	139,038	**155,605**
Sarawak[12]	126,578	137,281	133,248	137,824	132,240	132,007	107,102	123,476	223,165	115,952	118,512	**116,030**
Egypt[13]	84,974	94,545	88,555	89,935	84,998	83,412	143,978	157,533	208,377	211,841	221,156	**308,946**
France	40,840	43,589	42,839	48,545	43,189	43,574	43,000[1]	41,104	42,296	40,797	48,000[1]	**42,000**
Albania[16]	39,200	42,400	41,000	42,400	72,300	46,049	4,998	68,655	Nil	Nil	6,220	**43,000**
Hungary	12,461	13,976	13,775	18,691	26,018	25,888	30,900[1]	38,240	49,800[1]	52,000[1]	66,000[1]	**76,000**
Bolivia	7,128	9,100[1]	8,800[1]	9,000[1]	8,790[1]	9,500[1]	9,200[1]	8,500[1]	8,800[1]	8,500[1]	9,000[1]	**8,800**
Italy	7,969	9,612	9,459	9,563	8,646	9,378	9,057	8,267	8,622	8,533	7,937	**8,000**
Other Countries[17]	5,400	6,000	5,800	6,000	5,800	6,000	6,000	50,000	48,000	50,000	48,000	**50,000**
WORLD TOTAL	151,609,166	168,898,000	164,048,545	162,787,023	158,405,367	168,952,818	172,852,085	162,875,465	169,163,546	163,738,535	167,650,536	**168,008,824**

[1] Estimate.
[2] Includes natural gasoline production.
[3] International Petroleum Company and Lobitos Oilfields Ltd. figures combined.
[4] Russian Sakhalin included with U.S.S.R.
[5] Anglo-Iranian Oil Company Ltd. figures revised—fuel oil returned to the ground has been deducted.
[6] Bahrein Petroleum Company Ltd. figures.
[7] Does not include Assam or Punjab, which are listed together under British India.
[8] British Malayan Petroleum Company Ltd. figures.
[9] Includes Madura.

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Barrels

	Daily Av. 1938	Daily Av. 1937	Total 1938	Total 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States	**3,323,984**	3,504,200	**1,213,254,000**	1,279,160,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,159,000
Soviet Union	**564,909**	553,031	**206,192,000**	201,856,661‡	199,635,921	184,008,033	175,635,783	155,596,429	155,927,997
Venezuela	**475,360**	514,179	**173,506,497**	187,675,477	155,270,840	148,809,057	136,098,681	117,113,940	115,615,782
Iran	**213,970**	213,997	**78,099,125**	78,109,001	62,977,950	57,520,488	57,902,092	54,440,075	49,516,697
Netherland India: Sumatra	**94,625**	91,648	**34,538,128**	33,451,511	30,469,428	28,004,595	26,336,011	22,345,172	18,570,928
Borneo	**35,102**	35,507	**12,812,383**	12,960,072	13,068,910	13,529,185	14,335,543	15,003,175	15,228,615
Java	**19,056**	19,597	**6,955,283**	7,152,931	3,618,293	3,462,440	3,778,920	3,600,816	3,837,142
Ceram	**1,665**	1,472	**607,622**	537,436	375,823	311,872	273,698	285,335	309,957
Roumania	**132,508**	143,549	**48,366,000**	52,395,725	63,532,846	61,270,072	61,849,306	53,919,708	53,651,978
Mexico	**95,463**	127,102	**34,844,101**	46,455,687‡	41,027,915	40,240,563	38,171,946	34,000,830	32,805,496
Iraq	**88,778**	83,846	**32,404,000**	30,603,660‡	29,913,150	27,410,983	7,639,849	1,094,915	871,840
Colombia	**59,127**	55,609	**21,581,588**	20,297,543‡	18,756,110	17,597,655	17,337,900	13,156,126	16,415,214
Trinidad	**48,592**	42,474	**17,736,176**	15,502,989	13,237,030	11,671,224	10,894,363	9,561,353	10,126,121
Argentina	**46,784**	44,807	**17,076,223**	16,354,717	15,457,960	14,297,025	14,021,901	13,690,556	13,138,747
Peru	**43,584**	47,833	**15,908,279**	17,459,112	17,593,069	17,056,555	16,314,381	13,257,318	9,899,265
Bahrein	**22,734**	21,266	**8,297,998**	7,762,264	4,644,635	1,264,807	285,072	31,377	902
Burma	**20,748**	21,500	**7,572,089**	7,847,553	7,587,718	7,181,113	7,278,859	7,114,311	7,073,437
Canada	**19,004**	8,206	**6,936,479**	2,995,025	1,507,931	1,447,204	1,410,895	1,145,333	1,044,412
Brunei	**14,759**	12,047	**5,387,214**	4,397,038	3,296,938	3,302,905	2,705,350	2,035,656	1,200,026
Great Germany: Old Reich	**10,548**	8,626	**3,850,044**	3,148,300	3,076,858	2,967,438	2,204,402	1,656,602	1,594,807
Ostmark	**1,014**	606	**370,038**	221,266	50,092	44,347	27,965	5,765	804
Slovakia	**362**	336	**132,045**	122,790	126,603	136,580	177,797	121,695	126,603
Poland	**10,489**	10,411	**3,828,438**	3,799,862	3,869,575	3,901,881	4,011,336	4,174,079	4,219,634
Japan	**6,880**	6,816	**2,511,184**	2,487,841	2,403,072	2,294,878	1,872,837	1,504,412	1,683,439
British India	**6,281**	5,923	**2,292,524**	2,161,653	1,978,329	2,037,810	1,921,863	1,628,803	1,743,878
Ecuador	**6,184**	5,922	**2,257,278**	2,161,436	1,942,467	1,731,785	1,636,619	1,619,902	1,597,641
Saudi Arabia	**1,356**	178	**495,135**	64,968	19,777	Nil	Nil	Nil	Nil
Sarawak	**4,452**	4,535	**1,624,882**	1,655,565	1,547,882	1,776,593	1,942,591	2,206,815	2,329,733
Egypt	**4,277**	3,187	**1,561,231**	1,163,267	1,262,666	1,255,151	1,527,252	1,653,535	1,071,976
France	**1,414**	1,389	**516,240**	507,067	534,063	529,664	700,000	786,366	755,146
Albania	**1,199**	1,042	**437,597**	380,292	219,693	41,218	17,500	11,437	9,212
Hungary	**990**	38	**361,493**	13,910	100	Nil	Nil	Nil	Nil
Bolivia	**292**	337	**106,620**	123,123	104,746	163,295	157,875	111,973	41,907
Italy	**291**	309	**106,083**	112,700	129,653	128,615	162,449	213,534	242,563
Other Countries	**665**	192	**243,000**	70,000	37,100	32,300	64,000	54,100	73,300
WORLD TOTAL	**5,377,446**	5,591,717	**1,962,769,017**	2,041,168,442	1,797,891,143	1,652,023,331	1,516,760,036	1,438,797,443	1,305,574,242

‡Preliminary.

PRODUCTION

Figures in U. S. barrels of 42 gal.—Conversion ratios used are weighted averages for individual countries

METRIC TONS

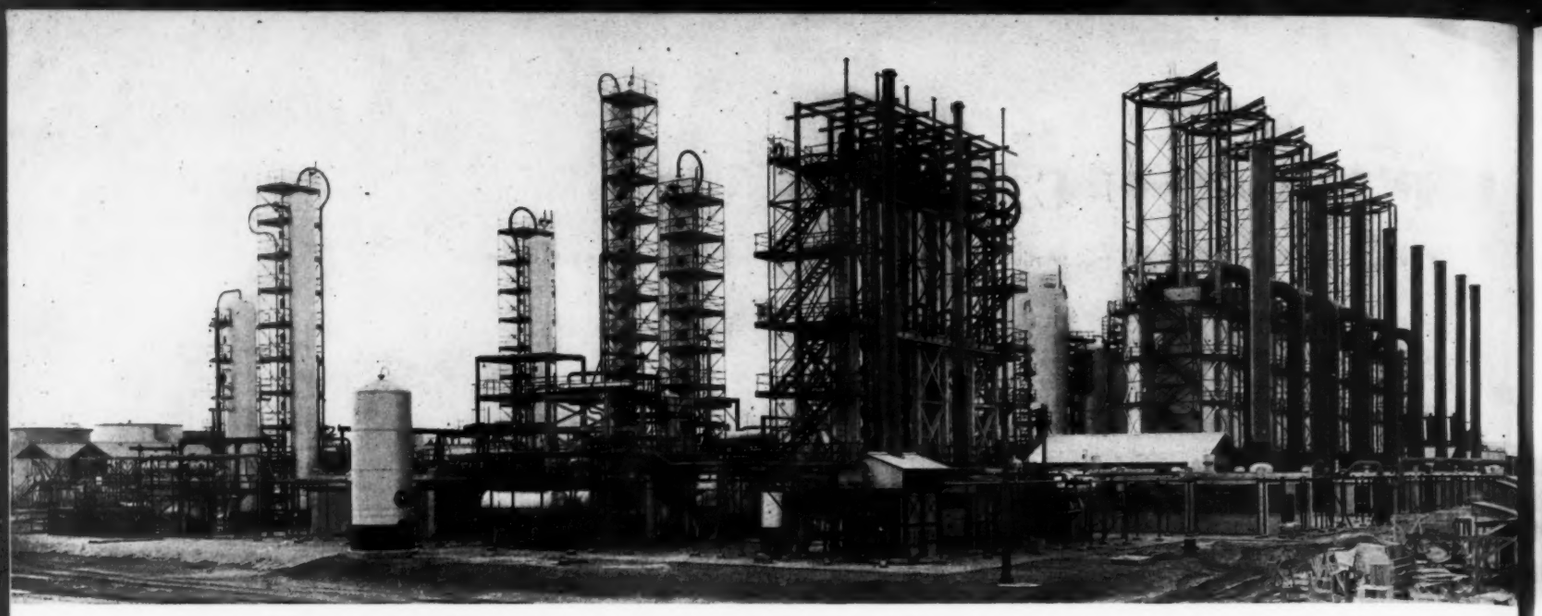
	Feb. 1938	March 1938	Apr. 1938	May 1938	June 1938	July 1938	Aug. 1938	Sept. 1938	Oct. 1938	Nov. 1938	Dec. 1938	Preliminary Figures Jan. 1939
United States	12,814,670	14,420,469	12,916,610	13,357,804	12,762,583	13,939,606	14,507,243	13,189,481	13,785,028	13,343,306	13,846,893	**13,874,374**
Soviet Union[4]	2,440,000	2,192,000	2,448,000	2,411,000	2,543,000	2,497,000	2,414,000	2,401,000	2,387,000	2,366,000	2,339,000	**2,332,000**
Venezuela	2,038,197	2,232,753	2,023,972	2,363,588	2,409,066	2,205,195	2,455,545	2,404,477	2,564,234	2,417,054	2,474,385	**2,450,000**
Iran[5]	848,360	1,095,647	937,768	922,528	766,064	706,120	775,208	750,824	943,864	955,040	845,000[1]	**940,000**
Netherland India: Sumatra	347,381	390,975	378,445	398,988	388,437	377,750	389,439	391,566	409,288	404,756	426,522	**420,001**
Borneo	135,341	149,588	141,775	143,124	135,995	142,549	130,294	143,607	150,752	146,310	149,602	**149,741**
Java[9]	79,297	86,385	85,850	90,460	82,798	78,535	70,387	64,754	70,285	515,160	71,095	**71,852**
Ceram	6,495	6,762	7,024	6,916	6,694	7,253	7,359	6,759	6,771	45,750	6,144	**6,604**
Roumania	512,175	570,239	558,362	568,874	548,139	561,775	556,415	534,475	550,000	525,232	541,884	**537,111**
Mexico	596,200*	182,061*	283,921*	341,745*	352,555*	297,000[1]	444,693*	482,500[1]	519,600[1]	486,200[1]	437,945[1]	**366,686**
Iraq	319,853	364,344	347,948	312,771	355,803	376,415	379,395	351,508	326,086	324,503	312,734	**323,797**
Colombia	210,242	256,700	228,878	253,615	254,514	254,669	260,629	250,475	263,669	259,768	266,046	**235,298**
Trinidad	183,622	202,425	199,666	208,456	201,446	211,113	211,928	213,185	224,385	211,580	234,214	**232,537**
Argentina[1]	183,600	198,000	192,200	196,900	191,900	192,200	193,800	193,500	194,000	193,500	288,930	**285,000**
Peru[3]	162,263	195,383	171,759	178,010	172,745	168,725	176,006	167,718	177,893	172,805	175,667	**166,281**
Bahrein[6]	95,450	100,478	94,457	84,723	90,435	95,428	97,279	97,479	96,660	83,585	85,009	**88,264**
Burma[7]	69,240	91,765	87,796	92,275	93,797	87,900[1]	87,800[1]	89,100[1]	87,800[1]	89,100[1]	87,800[1]	**89,100**
Canada[8]	52,193	60,739	58,649	71,511	67,934	87,586	103,298	111,686	86,545	56,280	61,812	**67,151**
Brunei[8]	49,965	58,376	56,230	58,416	55,552	59,464	58,772	62,688	62,607	63,491	66,939	**66,410**
Great Germany: Old Reich[14]	37,155	51,517	49,314	47,485	47,075	49,897	45,007	47,256	47,788	45,865	45,111	**47,562**
Ostmark[15]	5,253	5,820	5,697	4,900	5,800[1]	4,634	4,394	3,994	6,519	5,600[1]	5,111	**5,014**
Slovakia	1,526	1,776	1,566	1,601	1,484	1,521	1,609	1,597	2,008	1,534	1,600[1]	**1,600**
Poland	38,685	43,150	41,658	42,850	41,607	41,000[1]	43,287	42,366	43,590	42,000[1]	43,000[1]	**43,000**
Japan[10]	30,481	30,586	29,518	30,750	30,839	30,839	30,955	24,277	31,776	31,913	24,794	**31,003**
British India[11]	18,247	27,308	27,136	27,357	26,599	27,000[1]	27,600[1]	27,300[1]	27,000[1]	27,300[1]	27,000[1]	**27,000**
Ecuador	24,254	27,175	25,699	27,004	26,743	27,262	27,412	26,791	27,310	26,314	27,336	**27,715**
Saudi Arabia	516	328	305	492	451	460	453	5,498	18,570	20,697	18,590	**21,100**
Sarawak[12]	16,597	18,001	17,472	18,072	17,340	17,309	13,913	16,191	16,150	15,204	15,540	**15,214**
Egypt[13]	12,005	13,516	12,660	12,642	12,151	11,924	20,583	22,521	29,789	30,285	31,617	**44,390**
France	5,579	6,104	5,999	6,798	6,048	6,102	6,000[1]	5,756	5,923	5,713	6,000[1]	**5,900**
Albania[16]	5,650	6,200	6,060	6,200	10,790	6,873	746	10,247	Nil	Nil	41,674	**7,000**
Hungary	1,612	1,808	1,782	2,418	3,366	3,349	4,000[1]	4,947	6,400[1]	6,700[1]	8,600[1]	**9,800**
Bolivia	897	1,140[1]	1,110[1]	1,130[1]	1,100[1]	1,200[1]	1,160[1]	1,000[1]	1,100[1]	1,000[1]	1,130[1]	**1,100**
Italy	990	1,194	1,175	1,188	1,074	1,164	1,125	1,027	1,071	1,060	986	**1,050**
Other Countries[17]	770	850	830	850	830	850	850	7,000	6,700	7,000	6,700	**7,000**
WORLD TOTAL	21,344,763	23,091,564	21,441,537	22,293,441	21,512,754	22,567,667	23,548,584	22,154,494	23,177,761	22,927,605	23,022,340	**22,998,655**

[10] Japanese Sakhalin, Taiwan (Formosa) and Hokkaido included with Japan.
[11] Excluding Burma.
[12] Sarawak Oilfields Ltd. figures.
[13] Anglo-Egyptian Oilfields Ltd. figures.
[14] Prussia, Thuringia and Baden.
[15] Formerly known as Austria.
[16] Italian imports of Albanian crude oil.
[17] Nominal figure representing proportion to world total represented by: Morocco, Cuba, New Zealand, Barbados, Greece, Algeria, Yugoslavia, Australia, Great Britain, Kuwait and China.
* Official Figures—Petroleos Mexicanos.

Official Crude Oil Production Figures for 1932 to 1938 (Revised) in Metric Tons

	Daily Av. 1938	Daily Av. 1937	Total 1938	Total 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States	**447,202**	473,487	**163,228,715**	172,822,797	148,707,864	134,912,143	122,913,903	122,601,191	106,289,292
Soviet Union	**79,066**	76,348	**28,859,000**	27,867,025‡	27,384,900	25,241,100	24,092,700	21,330,100	21,389,300
Venezuela	**76,288**	75,983	**27,845,286**	27,733,926	22,945,299	21,990,373	20,112,115	17,293,193	17,085,334
Iran	**28,527**	28,303	**10,412,327**	10,330,480	8,329,289	7,607,500	7,657,970	7,200,093	6,548,941
Netherland India: Sumatra	**12,775**	12,302	**4,662,836**	4,490,137	4,114,710	3,759,006	3,535,035	2,999,352	2,492,742
Borneo	**4,712**	4,766	**1,719,783**	1,739,607	1,773,545	1,815,998	1,924,234	2,013,849	2,043,707
Java	**2,559**	2,630	**933,595**	960,125	499,097	464,757	510,320	483,331	515,187
Ceram	**224**	198	**81,560**	72,139	50,446	41,862	36,738	38,300	41,605
Roumania	**18,090**	19,597	**6,603,000**	7,153,000	8,704,000	8,394,000	8,473,355	7,387,000	7,350,321
Mexico	**13,806**	18,887	**5,039,322**	6,896,657‡	6,090,842	5,973,955	5,666,857	5,049,109	4,870,175
Iraq	**11,904**	11,305	**4,345,000**	4,126,185‡	4,079,066	3,724,231	1,048,108	147,943	118,887
Colombia	**8,241**	7,792	**3,007,935**	2,844,251‡	2,614,092	2,452,635	2,416,432	1,833,606	2,287,835
Trinidad	**6,748**	5,977	**2,462,943**	2,181,676	1,862,796	1,642,446	1,533,122	1,345,532	1,425,009
Argentina	**6,665**	6,384	**2,432,857**	2,330,063	2,202,304	2,036,903	1,997,706	1,950,499	1,871,882
Peru	**5,753**	6,339	**2,099,885**	2,313,691	2,331,454	2,260,903	2,161,990	1,756,867	1,311,856
Bahrein	**3,098**	2,900	**1,130,734**	1,058,557	635,555	173,072	39,008	4,293	123
Burma	**2,875**	2,968	**1,049,493**	1,083,391	1,047,593	991,456	1,004,951	982,233	976,589
Canada	**2,400**	1,037	**876,016**	378,430	190,495	182,820	178,233	144,686	131,937
Brunei	**1,937**	1,580	**707,123**	576,545	470,991	471,842	386,478	290,808	171,432
Great Germany: Old Reich	**1,513**	1,242	**552,074**	453,451	444,600	427,400	317,500	238,600	229,700
Ostmark	**174**	91	**63,468**	33,010	7,473	6,616	4,172	860	120
Slovakia	**53**	49	**19,439**	17,936	18,665	19,946	25,971	17,776	18 493
Poland	**1,383**	1,373	**504,678**	501,301	510,630	514,760	529,200	550,670	556,680
Japan	**976**	970	**356,328**	354,040	341,976	326,580	266,520	212,667	239,567
British India	**868**	818	**317,004**	298,450	273,137	281,072	265,341	224,879	240,767
Ecuador	**876**	839	**319,877**	306,326	275,293	245,434	231,947	229,578	226,423
Saudi Arabia	**183**	22	**66,683**	8,070	2,447	Nil	Nil	Nil	Nil
Sarawak	**548**	595	**200,126**	217,085	221,126	253,799	277,513	315,259	332,819
Egypt	**611**	456	**223,038**	166,298	177,491	176,436	214,671	232,437	265,055
France	**198**	194	**72,106**	71,008	74,788	74,172	98,095	110,120	105,758
Albania	**179**	156	**65,313**	56,760	32,760	6,152	2,500	1,707	1,375
Hungary	**128**	38	**46,760**	13,910	13	Nil	Nil	Nil	Nil
Bolivia	**36**	42	**13,262**	15,487	13,197	20,540	19,858	14,085	5,284
Italy	**36**	38	**13,178**	14,000	16,106	15,977	20,180	26,526	27 046
Other Countries	**93**	27	**34,080**	10,000	5,300	4,600	9,100	7,700	10,500
WORLD TOTAL	**740,725**	765,733	**270,364,844**	279,495 814	240,539,340	226 410,486	207 970,753	197,024,849	179,181,741

‡Preliminary



Debutanizer-stabilizer, caustic wash, depropanizer, hydrogen sulphide removal, dehydrat or, and catalytic polymerization units, looking southwest.

Polymer gasoline of the desired vapor pressure and cracked casinghead are mixed as made and thence passed through the caustic wash unit. This removes about 75 percent of the mercaptans and materially decreases the load on the sweetening system.

The combined products are intimately mixed with about an equal volume of dilute caustic solution and the mixture settled. The gasoline from this separator is routed directly to the finishing operation. The spent caustic solution is steam stripped and cooled for re-use.

Debutanizer bottoms, after treating and rerunning, plus the caustic treated casinghead and poly stock are blended and subjected to a final sweetening operation which results in a finished gasoline.

CONSTRUCTION

The co-ordination of all phases of the construction of Richfield-Watson refinery —the manufacture of the major equipment and field erection—was undertaken and completed by C. F. Braun & Co. The process-design was provided by the Sinclair Refining Company while working-drawings were prepared by the Braun staff and Sinclair and Richfield engineers worked jointly with Braun in the completion and settlement of design-details.

The main plant is a double combination unit for combined topping and cracking—two units operate in parallel. The total charge is 50,000 bbl. per day. The auxiliary units take care of debutanization, stabilization, hydrogen-sulphide removal, dehydration, depropanization, caustic-wash, and catalytic polymerization. The new water-system, cools and circulates 24,000 gal. per min.—35,000,000 gal. per day.

All of the major refining equipment was manufactured at the Braun plant, and some 10,000 units of piping and accessories were fabricated and tested. All of this was shipped to the site ready for field-assembly.

There are throughout the plant, twenty-two Braun bubble-columns, and 110 Braun heat-exchangers, condensers, and coolers. Sections of the cracking-columns operating above 600 deg. F., are lined with 11 to 13 percent chrome-alloy, and are equipped with alloy bubblecaps and trays. High-temperature exchangers are similarly protected and are equipped with alloy tube-bundles.

The co-ordination and scheduling of all phases of the work was planned and conducted throughout the job, by the Braun production division. Delivery was co-ordinated with the planned erection schedule, so as to permit moving the work direct into position from cars or trucks, without rehandling.

The foundations and reinforced concrete buildings, required some 7,000 cu. yd. of concrete. The main pump-and-receiving house was poured in two stages: the lower-floor, framework, and ceiling in a continuous pour, 580 yd. in 21 hr.; and the top-floor and roof, 220 yd. in seven hours. All concrete work and steel structures, were built for earthquake resistance.

The steel structures—furnaces, support-steel, platforms, craneways—involve some 2,000 tons of steelwork. Gantry-cranes with traveling hoists and monorail hoists, are provided for the removal and handling of heat exchanger-heads, tubebundles, condenser-sections, furnace tubes and headers.

A gallows-frame and three heavy-duty hoists, suitable for vessels 15 ft. in diameter and loads of 175 tons, were used for erection of the large bubble-columns. Other rigging equipment included three traveling cranes, two riggers hoists-trucks, seven tugger-hoists, and a stiff-leg derrick. Highlines, suspended from 110 ft. gin-poles and served with power-hoists, were used for rigging piping and accessories into restricted areas.

Two spur-tracks were installed to provide for convenient handling of the major equipment. The rigging facilities were arranged so that the 90 to 140 ton bubble-columns were placed on their support structures within one hour from the time the carloads were spotted in position. The columns were manufactured and shipped in planned order so that the rigging equipment could be moved in one direction in short steps, without back-tracking.

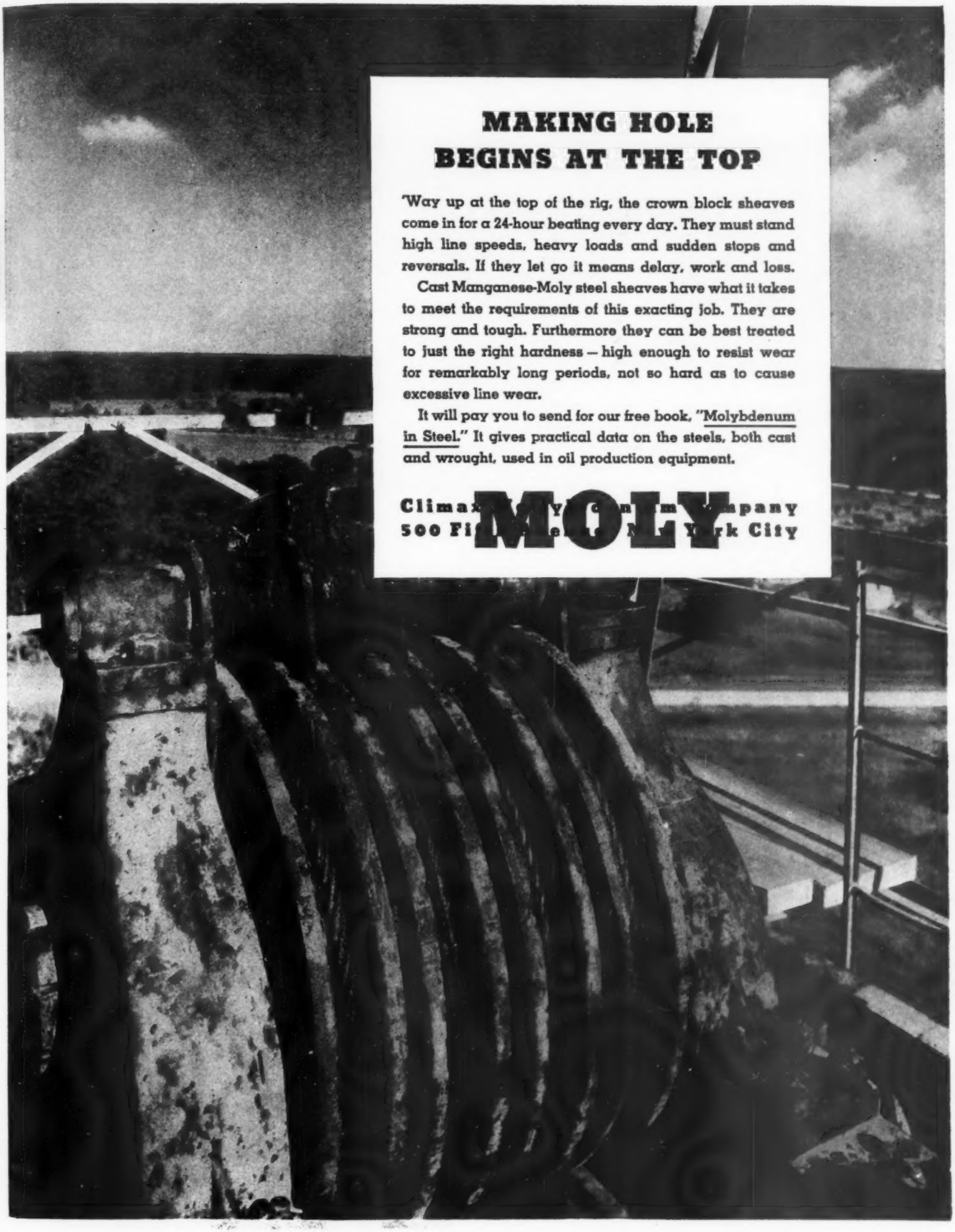
The piping, comprising some 6,000 separate units, was fabricated and tested at the Braun plant. The process-lines for temperatures 600 deg. F. and higher, were fabricated from alloy-steel, and were provided with vanstoned flanged joints, so as to avoid insofar as possible, the use of welding on the alloy-steel. These lines were made of low carbon alloy-steel with columbium, to reduce the possibility of air-hardening defects. Vanstoned-joints of the globack-form, were used for services requiring Series 30 or higher pressures. All other process-lines were of carbon-steel construction; cast-iron served only for low-pressure utilities.

The electrical power distribution system is carried underground. Wiring for lights and instruments was run in conduit mainly overhead and supported on racks. The underground wiring is lead-covered cable, run in conduits encased in concrete.

The six DeFlorez vertical cracking furnaces, have as heat-absorbing surface, a total of some seven miles of alloy-tubing. The tubes are rolled into alloy-steel headers. There are 1,900 of these rolled joints. No leaks occurred on any of these joints, either under hydrostatic test or during operation under temperature.

The refinery water-system, installed concurrently, cools and circulates 24,000 g.p.m. An existing cooling-tower was rebuilt, and a new Braun cooling-tower installed.

An outstanding safety record was made for construction work of this magnitude, and the old superstition that one life is lost for each $1,000,000 of construction work was thoroughly disproved.


MAKING HOLE
BEGINS AT THE TOP
'Way up at the top of the rig, the crown block sheaves come in for a 24-hour beating every day. They must stand high line speeds, heavy loads and sudden stops and reversals. If they let go it means delay, work and loss.
Cast Manganese-Moly steel sheaves have what it takes to meet the requirements of this exacting job. They are strong and tough. Furthermore they can be best treated to just the right hardness — high enough to resist wear for remarkably long periods, not so hard as to cause excessive line wear.
It will pay you to send for our free book, "Molybdenum in Steel." It gives practical data on the steels, both cast and wrought, used in oil production equipment.
MOLY

Foreign Oil Legion

W.P. Staff Photo

C. Engelbrecht, director of Deutsche Vacuum Oel A.G., who is in charge of the company's crude oil operations as well as other activities, snapped informally at his desk in Hamburg, Germany.

ROBERT L. HAGUE, manager of the marine department of the Standard Oil Company of New Jersey, who directed the largest privately owned fleet in the world, died March 8th in his apartment in the Ritz Tower, New York.

Robert L. Hague

Blackstone Photo

AT A SPECIAL meeting of the board of Gulf Refining Company in Pittsburgh on Feb. 1st, B. P. NEWTON, vice-president of Gulf Oil Corporation in charge of export activities, was elected a director to succeed the late Charles Buerger. Mr. Newton sailed from New York, February 4, for his annual inspection of his company's European marketing operations. On Feb. 1st W. V. HARTMANN was elected a director of Gulf Oil Corporation and J. E. NELSON, treasurer of the company, was made a vice-president.

DR. NELSON DANTAS, president of the Panal Company of Brazil, will arrive in New York in June on a two months' visit to various oilfields and oil shale plants in the United States, France, and Czechoslovakia. Dr. Dantas is well acquainted with New York City, where he studied banking. Manganese mining, however, lured him from a financial career in the coffee business, and for the last few years he has been absorbed in the study of petroleum, having acquired what appears to be a high grade oil schist deposit.

Dr. Nelson Dantas

This deposit is fortunately situated alongside the Central Railway of Brazil, near the two largest centers of petroleum consumption in the country. Having brought the business through the preparatory stages himself, Dr. Dantas two years ago founded, and controls, the actively-operating "Companhia Nacional de Oleos Mineraes, S.A. (Panal)." It is he who is responsible for the first petroleum to be produced in Brazil.

H. C. BROWN, head of North Venezuela Petroleum Company in Caracas, recently made a flying visit to the United States, spending four days in Texas and three in New York City. His company is drilling a

H. C. Brown's departure from New York was a cheerful one and his many friends had difficulty in all getting in the cabin at once. Those shown are, from left to right: Fred Convers; W. G. Foster, leaning forward; W. J. Campbell; and Mr. Brown, himself.

W.P. Staff Photo

WORLD WIDE EXPERIENCE

Oh, East is East, And West is West, And Never the Twain Shall Meet.

Rudyard Kipling

In South America, central offices in Trinidad, serve our crews operating in Trinidad, Venezuela, British Guiana and Argentina. In addition to several crews working in the Far East and the Dutch East Indies, SSC Geophysical Exploration extending from the frozen wastes of Little America to the unchartered corners of the World has resulted in the discovery of more than 44 NEW PRODUCING OIL FIELDS, an imposing contribution by one Company to the oil reserves of the World.

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Seismograph Service Corporation

CONSULTING EXPLORATION GEOPHYSICISTS

KENNEDY BUILDING

TULSA OKLAHOMA, U. S. A.

wildcat in the state of Guarico which is now being side-tracked at 1,000 ft. Mr. Brown returned to Venezuela on board the SANTA ELENA February 24th.

I. FRANK BROWN, export representative in New York of several petroleum equipment companies, returned to New York February 24th after completing a five-month trip through South America and the U.S.A. He visited the Gulf, Carribean and Lago oilfields in the Maricaibo Lake basin as well as Quirequire and Caripito in eastern Venezuela; the Tropical and Barco concessions in Colombia; and Trinidad. Pausing in New York only a few days, Mr. Brown proceeded to the Pacific coast where he visited the principal oilfields. He also covered East Texas and Oklahoma.

I. Frank Brown, operating the working model of an oil derrick and rig which he had installed in his office to demonstrate drilling equipment. The rack contains scale-size drill bits, reamers and fishing tools for this model.

W.P. Staff Photo

ERNESTO ESCOBAR, representative at large of the Ecuadorian Government, is visiting the United States in connection with oil affairs. He left New York March 4th for Los Angeles, and will be spending some time in the California oilfields.

CLEMENT A. BARRERE has resigned from Bradford Oil Refining Company, Pennsylvania, to join the Lummus Company as process and sales engineer. Mr. Barrere, who was manager of Bradford for two years, has had wide experience in refining and particularly in cracking.

Clement A. Barrere

CHAS. W. THORNHILL, vice-president of Thornhill-Craver Company, Houston, Texas, left Miami, Florida, by plane early in February on the first leg of an extended tour of South American fields that will require several months. The first stop was Barranquilla, Colombia, through which country he will travel by air, water, and rail to reach all points of important activity, thence to Ecuador, Peru, and Chile. His schedule calls for his return to Maracaibo from the northern interior of the continent within two months and he then will proceed through Eastern Venezuela to Port of Spain, Trinidad. Here he will be met by Mrs. Thornhill, who will accompany him to Rio De Janerio and Buenos Aires, from which point Mr. Thornhill will fly to Patagonia, in the extreme lower section of the Argentine Republic.

LLOYD G. ENSIGN, well-known export representative in New York, left on March 1st for Miami whence he will fly to Trinidad and spend about three weeks inspecting the oilfields. From Trinidad Mr. Ensign goes to Eastern Venezuela, then to Caracas and Cucuta, Colombia. From Cucuta he will visit the Barco concession. He expects to visit the location of all important oil operations and to spend some time in Bogota before proceeding to Ecuador via Panama. During the early part of May he will arrive in Peru and after inspecting oilfields there will return to Cuba, spending a few days at the Atlantic drilling location and at the Shell development. Mr. Ensign expects to return to New York June 1st.

W.P. Staff Photo

Lloyd Ensign

J. L. ADLER, manager of international operations of Independent Exploration Company, recently returned from Central America where he had spent three weeks investigating the geology of prospective oil regions. Mr. Adler's trip is significant of the growing importance of Central America to the future of international oil production. It seems likely that geophysical reconnaissance may be carried on in the regions visited by Mr. Adler.

W.P. Staff Photo

J. L. Adler

VAL R. WITTICH, JR., who maintains headquarters for his foreign sales organization at 30 Rockefeller Plaza, New York, reached Trinidad early in March on the first leg of a journey through South American oilfields.

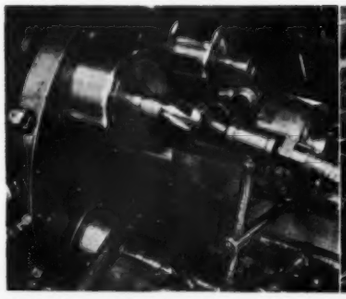
PUMP LIFE LENGTHENED HERE . . .

Twenty to sixty thousand times a day at least two balls—and often four—smack down on their seats in a deep well pump. It takes something to stand these shocks day after day, month on month. Add sand, shale, sulphides or other abrasive or corrosive conditions, plus the pressure of the fluid column and temperature, and the job of a seat and ball becomes as tough as anything in mechanics.

Axelson Seats and Balls have faced these conditions for forty years and met them successfully, step by step, as wells went deeper and jobs grew harder. Knowing the conditions in different oil fields and different wells, Axelson selects materials, proves processes, determines sizes and hardnesses, to meet any pumping requirement anywhere. A few of the operations and precautions in making seats and balls that lengthen pump life are shown here. An illustrated booklet is available on request.

1. Hot acid test on solid bar stock.

2. Chemical test on bar stock.



3. Turning seats from bar stock.

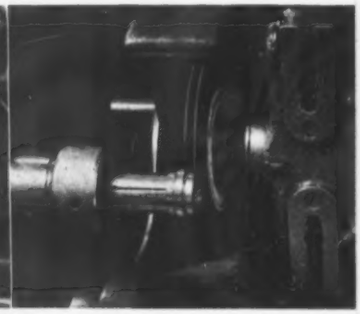
4. Facing seats on cut-off ends.

5. Inspecting for correct dimensions.

6. Heat Treatment.

7. (Below) Carburizing seats.

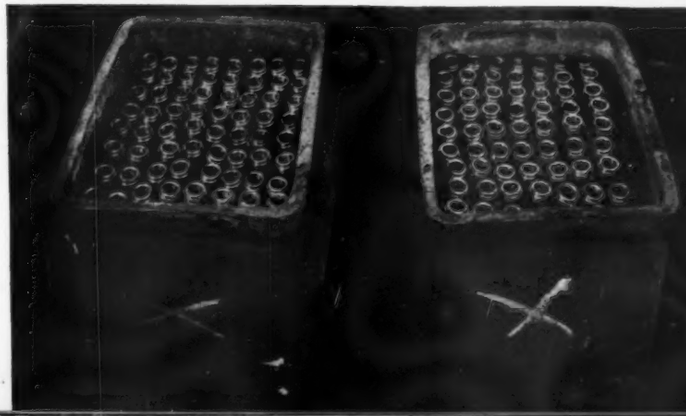
8. Centerless grinding.



9. Finishing flanges.

10. Lapping balls individually to mating seats.

11. (Below) Testing to 28-point vacuum.



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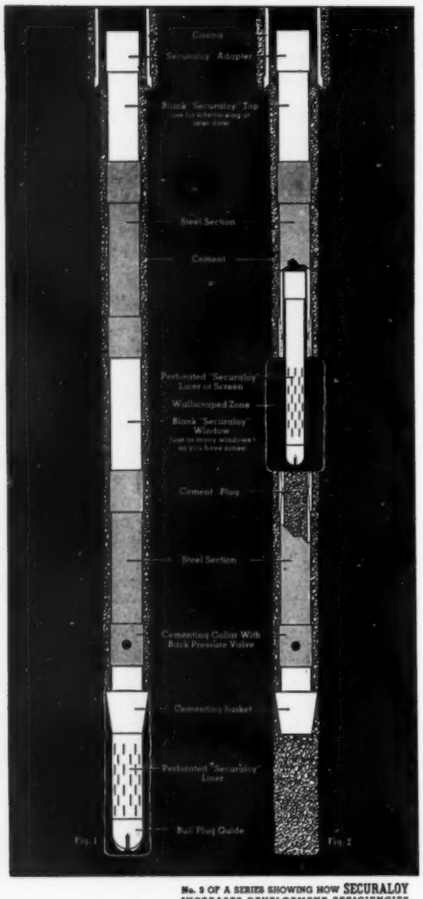

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Operators are now developing Secondary Producing Zones more efficiently, more economically and more *completely* with the aid of "Securaloy"—the drillable oil field metal.

Here is how it's done. The liner string used to produce the lowest production sand is made up with blank "Securaloy" sections opposite *all* other zones that offer production possibilities. This combination steel and "Securaloy" string is then run in the hole and cemented above the lowest producing zone (fig. 1), thus sealing off all undesired water, gas, and secondary oil zones.

The lowest zone is produced until it becomes depleted—or until it is thought desirable to open up the secondary zones. If depleted, the "Securaloy" liner section in this lowest zone is drilled up and the formation cemented off. The "Securaloy" window opposite the next lowest zone (together with the cement sheath behind it) is then completely cut away with a wall scraper.

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With the bottom zone plugged off and one of the secondary sands thus completely exposed to production, a new "Securaloy" liner or screen of smaller diameter can be set opposite this zone and production obtained with maximum efficiency (fig. 2). Thus, full drainage area is secured—an important advantage over producing through casing perforations—and the entire zone can be periodically scraped to open up fresh *unclogged* formation. Moreover, the liner can be reconditioned or replaced, as desired, thereby assuring unrestricted flow and *complete* recovery. The remaining sands can be progressively exposed and produced in the same manner by removing the "Securaloy" windows which blank off these zones.

And there is another important advantage. By exposing the entire formation, screens placed in these areas are not subjected to the destructive jetting action which sometimes takes place when production is concentrated through holes made in casing.

Furthermore, should it later be desired to explore for other zones, the use of a drillable "Securaloy" top section permits the hole to be diverted at this point and drilling operations to be carried around the steel sections in the hole to greater depths or other locations with minimum effort and maximum safety.

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BARCO

(Continued from page 86)

pushed on a tank farm that is to constitute the starting point for one of the world's outstanding pipelines. From the tanks, at an elevation above sea level of only 700 ft. the 12 in. line climbs to the top of the West Barco ridge, then dips onto the plain, across the Sardinata toward the precipitous mountains of the Eastern Cordillera. Here the line mounts rapidly to an elevation of 5,400 ft. with three powerful pump stations forcing the oil to the high point near Concepcion. From the mountains the oil flows by gravity the remaining distance to Covenas on the Gulf of Morrosquillo.

One of the main technical problems in designing the line was to break the terrific pressure built up by the loss of elevation on the western slope of the mountains. The line crosses the Magdalena a few miles below La Gloria at a point that has been designated Puerto Sagoc. From the river westward the right of way leads through low swampy lands, a large portion of which are inundated during several months of the year. Covenas, the Caribbean terminal of the line, was formerly the location of a meat packing plant. A pier to deep water was constructed to serve this plant but meat packing operations have been suspended and the pier will be used to load tankers from the storage tanks now being erected.

The difficulty in getting equipment and supplies to the mountainous parts of the right of way can hardly be over-emphasized. When work was begun, six days on mule back were occupied in reaching certain points on the line. Four airfields have been constructed along the line and some of the lighter equipment is being moved in Ford tri-motor planes. The entire line will be paralleled by a road that will be available for public use when the line is completed and will serve to open up a large area to agricultural and other types of general development.

The pipeline itself is 12 in. in diameter, 230 miles long and will have an initial capacity of 25,000 bbl. per day. By various easily-made modifications, however, the capacity of the line can be very substantially increased if technical and economic factors warrant. The line is welded throughout and constructed to withstand unusually high pressures.

The rapid development of oilfields on the Barco concession, building the pipeline and road, and laying out landing fields will have a significant effect on a large area in Colombia, hitherto unproductive and difficult of access. It is expected that the line will be completed during the coming summer.

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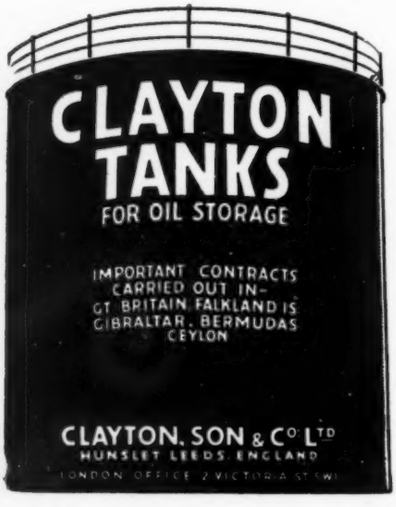

THIRD WORLD PETROLEUM CONGRESS

DETAILS of the Third World Petroleum Congress are already being arranged and April 1st, 1940, has been set as the final date on which registrations can be received. Those planning to present papers are requested to send them to Dipl.-Ing. Herbert Kahno, general secretary of the Congress, Dorotheenstrasse 36, Berlin, N.W. 7, Germany, by February 1st of that year.

The Congress, which is to be held from June 9th to June 15th next year, will bring the members to a country where the occurrence of natural petroleum is scarce, by comparison to other countries. It is in Germany, however, that processes have been invented and developed whereby liquid and gaseous products are obtained from indigenous coal and the nation has also contributed materially to the technique of petroleum treatment in those countries possessing a fully-developed oil industry.

Following the precedent of the two previous congresses in London (1933) and Paris (1937), the scientific work of the 1940 Congress will be divided into plenary and sectional meetings. General reports will summarize the main aspects of various technical problems and specialized topics will be presented through the medium of papers and their discussion in section meetings. The scientific work will be supplemented by tours and excursions of both technical and social interest before and after the Congress. Special visits and functions will be arranged for ladies taking part in the Congress and arrangements are being made for tours to Vienna and Cologne as well as to the exhibition of chemical apparatus (Achema) at Frankfurt.

The Third Congress is being held under the patronage of Ministerpraesidenten Field-Marshal General Goering while Herr Funk, Reichs-Minister of Economics and President of the Reichsbank, will serve as honorary president. The president of the Congress is Prof. A. Bentz, commissioner of Field-Marshal General Goering for the exploitation and production of oil. The following vice-presidents have so far been elected: Dr. E. R. Fischer, general deputy-president; Prof. A. W. Schmidt, scientific organization, and Director Hans Brochhaus, finance and organization.

MEXICO

(Continued from page 102)

amount nearly 8,000,000 ounces were taken from current production and the balance from prior years' stocks or demonetized coinage. In addition it purchased and held some 2,500,000 ounces of newly mined metal which we assume will be coined later.

Secretary of Treasury Morgenthau made the official statement nine days after the expropriation decree of President Cardenas that "in view of the decision of the government of the United States to re-examine certain of its financial and commercial relationships with Mexico, the Treasury will defer continuance of the monthly silver purchase arrangements with Mexico until further notice." The Department of Commerce reports show, however, that instead of curtailing or deferring continuance of the purchasing arrangements with Mexico, the United States purchased $60,600,000 worth of gold and silver during the first eight months of 1938 as compared to $48,800,000 during the same period in 1937.

The total Mexican silver absorbed by the United States Treasury in 1938 amounted to 35,000,000 ounces contributed by the Mexican Government in addition to Mexico's 1938 mining production of 85,000,000 ounces.

That the continuance of the U.S. Government's silver purchasing policy has been a God's-send to Mexico is revealed by EL UNIVERSAL in Mexico, D. F. on November 28, which said:

"Bankers and business men are worried over the possibility that the United States Treasury will suspend silver purchases . . . There would be, to begin with, a sharp decline in price, which would probably bring silver down to the level of the industrial metals . . . Therefore, a catastrophic decrease in prices would cause a semi-paralyzation of the mining industry . . . The volume of exports from Mexico to the United States during the first eight months of 1938 was $9,000,000 under that for the same period of 1937. However, this decrease was largely compensated by exports of gold and silver which increased from $48,000,000 to $60,000,000 . . . Were it not for this fortunate increase we would have felt the consequences of the decrease in oil exports in all their magnitude. And undoubtedly we would feel these consequences in the event that with the triumph of the opponents of the Roosevelt policy, the feared suspension or postponent of silver purchases should take place. We would not be able to import—since we would not be able to pay for them—many articles essential for the life of the collectivity, such as wheat and corn, which we have imported in large quantities during the eight months from January to August, 1938. Local sales would likewise decrease; many factories would shut down and we would enter into a period of acute crisis."

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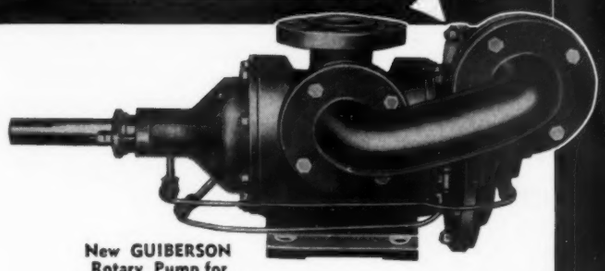

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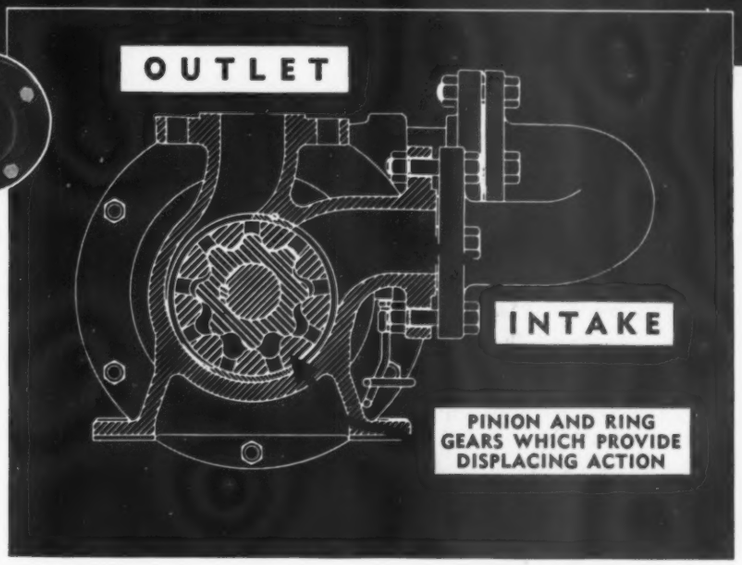
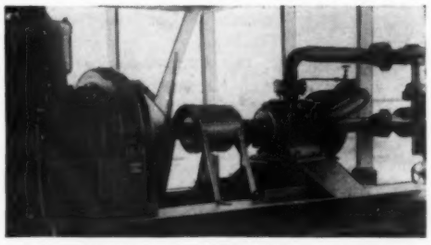


Type 4FB8 Diesel Driven Unit, Illinois Field, Direct Connected, 1400 R.P.M.

Type 4FB8 Dual Wheel Trailer, K.M.A. Field, Texas. Average Pressure 550 Lbs. Capacity 145 Barrels per Hour



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WORLD PETROLEUM ABSTRACTS

Summary of the Technical and General Literature

Dealing With Colombia; Compiled and Edited by

Dr. O. W. Willcox

Although there is a large amount of information about Colombia printed in Spanish, not a great deal is to be found in English publications that are accessible to the general reader. Below are given titles of books that are likely to be found in a large public library. To these are added papers and reports of a technical nature printed in the leading petroleum journals.

General

History of Colombia, by J. M. Henao and Gerardo Arrubla, in two volumes. English translation by J. Franke Rippy; this standard work tells the interesting history of Colombia from the earliest introduction of civilization down to the present time.

Conquest of New Granada, by Cunningham Graham. This is a stirring account of the subjugation of the region by the early Spanish conquistadors.

Colombia—by Phanaer Eden. A general description and discussion of conditions in the country. (1919).

A History of Diplomatic Relations Between Colombia and the United States, by J. Franke Rippy.

Credit Position of Colombia. Institute of International Finance. Describes the situation as it existed in 1929, with particular emphasis on basic economic features.

Handbooks

The South American Handbook, 1938. This standard reference book has 24 pages devoted to condensed information about ports, railways, air lines, rivers, chief cities, hotels, agricultural products, lands, forests, mineral wealth, exports and imports, currency, weights and measures. There is also a brief history of the country and an outline of its governmental system.

Colombia—A Commercial and Industrial Handbook, by P. L. Bell, issued by Bureau of Foreign and Domestic Commerce, Washington 1921. This work is somewhat out of date but still contains some valid information; the same remark applies to the next citation.

Colombia Year Book, by A. Martinez, 1927.

Other Reference Books

Encyclopedia Britannica; see article on Colombia.

The Science of Petroleum, vol. 1, pages 111-117. A chapter on Colombia gives a condensed outline of the geology and particularly of the known or suspected oil-bearing formations.

Petroleum Developments and Technology: issued annually by the American Institute of Mining and Metallurgical Engineers. The later volumes contain chapters on developments and oil production in Colombia.

Travel

Vagabonding Down the Andes, by Harry Frank. Gives the experience of a traveler, and observations on the people.

Colombia, Land of Miracles. Blair Niles (1925).

Up the Amazon and Down the Magdalena, by H. J. Morgan.

Quito to Bogota, by A. C. Veatch.

Conditions in Colombia, P. L. McGreal, Oil & Gas Journal, vol. 23 (1924) No. 14, p. 34. A report of four years' experience in Colombia.

Novels

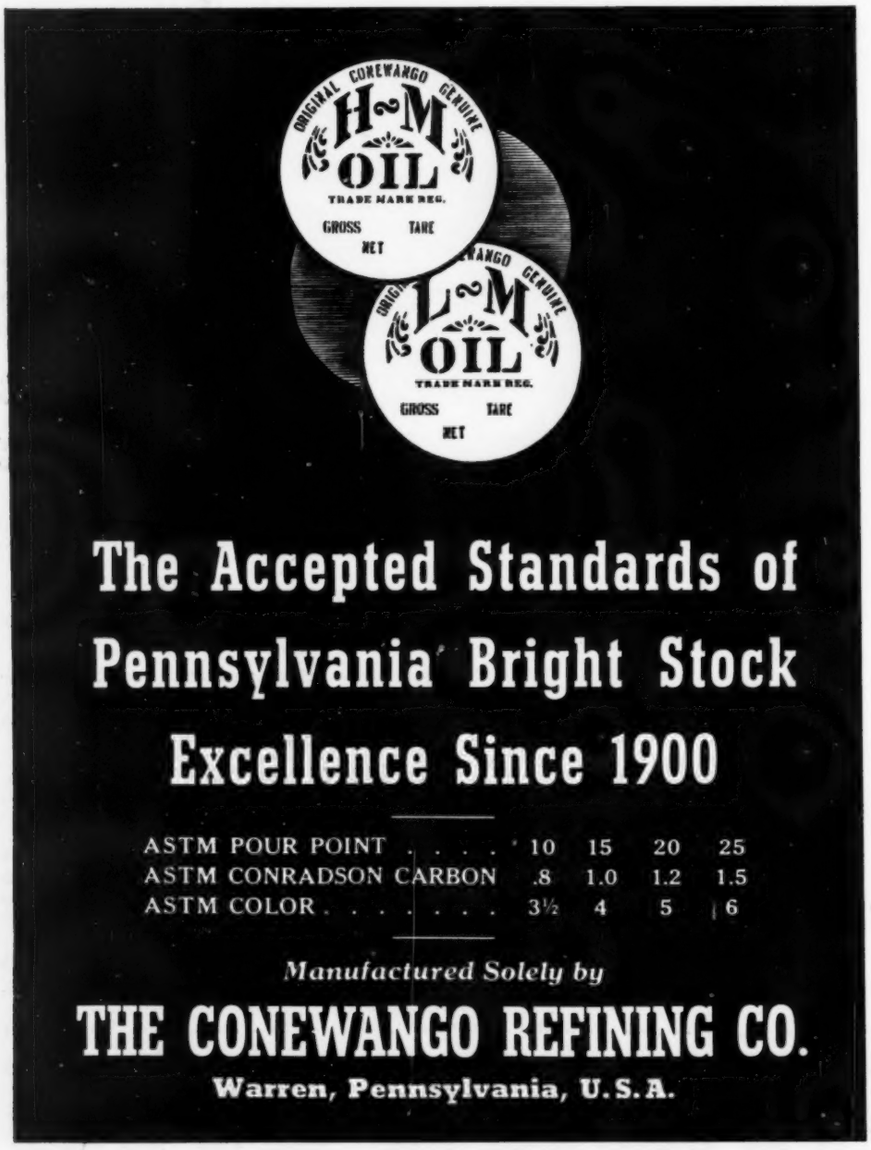
The Vortex, by Jose Eustasio Rivera. Useful for obtaining local color.

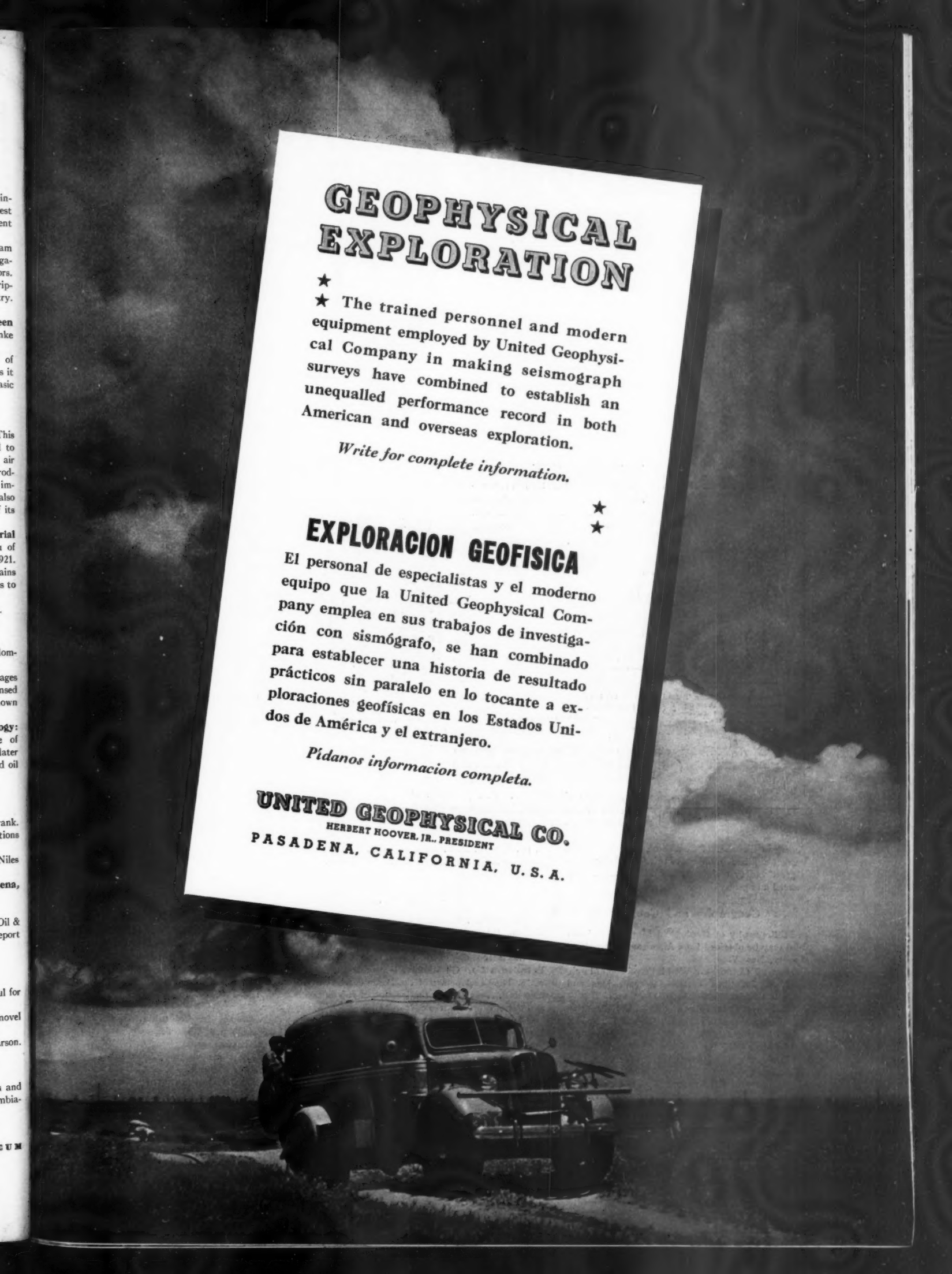
Carmen Ariza, by Frank Stocking. In this novel part of the scene is laid in Colombia.

Trangressor in the Tropics, by Negley Farson.

Periodical

Colombia: a monthly magazine in English and Spanish under the auspices of the Colombia-

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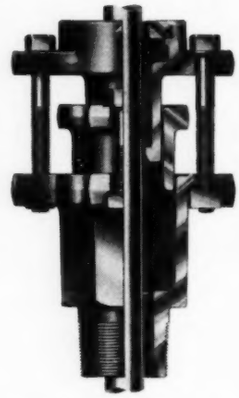
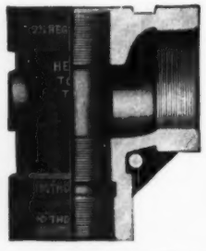
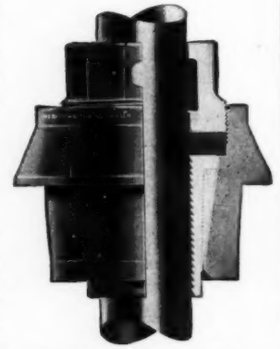


Hercules Duplex Polish Rod Stuffing Box.



Hercules Combination Thread Pumping and Flowing Tee —nickel chrome steel—3000 lbs. test.



Hercules Forged Steel Tubing Hanger—for use in Berry pattern casing heads.

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American Chamber of Commerce, New York. The current and back numbers of this magazine contain a great variety of information on industrial, commercial and general conditions.

Geography and Geology

Bibliography of Geological Maps of Colombia; may be obtained from American Geographical Society, New York.

Map of Colombia. World Petroleum, March, 1939, p. 29. Shows refineries, concessions and active oil fields. Size 25x36 in. 11 colors.

Geology of Colombia Oil Fields. L. G. Huntley and Shirley Mason in Oildom, 1922, vol. 13, No. 11, page 41.

The Meta Oil Region of Colombia, described in Oil Engineering and Finance, vol. 2, p. 359, by H. C. Wilcox.

Geology and Oil Resources of Colombia, by Elfred Beck. Economic Geology, vol. 16 (1921), No. 7, pp. 457-473. Discusses topography, underground waters, stratigraphy and oil bearing formations.

Oil Fields

Development in Barco Concession, by C. O. Willson, Oil & Gas Journal, December 15, 1938, p. 18.

The Barco Concession and the Colombia Petroleum Co.; Oil Weekly, December 21, 1936, p. 16. The development of the Barco concession is described. A map shows the location of Rio de Oro and Petrolea fields in the concession.

Oil Fields of Colombia, by C. C. A. Lee, Petroleum Times 1924, No. 292, p. 221. In a report to the Department of Overseas Trade the importance of transport facilities in the future development of Colombia is pointed out both as regards the oil industry and practically every other branch of activity.

The Oil Fields of Colombia. National Petroleum News, 1924, No. 35, p. 48. At this time the Tropical Oil Co. had 19 drilling rigs on its De Mares concession in interior Colombia, with a field force of 300 foreign employes and 3100 natives.

Oil Fields of Colombia. H. W. Driggs, Petroleum World, 1924, No. 10, p. 44. Describes and discusses drilling conditions, marketing conditions and potentialities of production.

Oilfields of Colombia. M. J. Stephen, in Petroleum Times, vol. 9, 1923, p. 745.

Oil Fields of Colombia. Launcelot Owen, in Oil Engineering and Finance, 1924, No. 103, p. 624. Gives data on geography, geology, and oil and gas indications; shows correlation of Colombia territory belt with other fields.

Oil Fields of Colombia. A. Martinez, in Oil & Gas Journal, 1924, No. 30, p. 119. Discusses petroleum production, the oil bearing formations, chief concessions, oil legislation and public policies.

Oil Fields in Colombia; Petroleum Gaz., May, 1918. Petroleum Zeit. (in German). Discusses the Sinus River oil fields, and a loss of $1,500,000 by the Standard Oil Co. in unsatisfactory developments. Particulars are given of the Magdalena coal and oilfields 400 miles from the coast; also oil from the region of Maracaibo Lake.

Development and Production

Petroleum Operations in Colombia. G. Howell, in Oil Engineering and Finance, vol. 3, p. 491. Describes the operations of the Tropical Oil Co.

Petroleum Development in Colombia. Petroleum Engineer, August, 1937, p. 122. Describes the great difficulties encountered and how they are overcome.

Colombian Petroleum Co. Oil, Paint and Drug Reporter, April 26, 1937. Discusses the purchase of the Carib syndicate's holdings in Colombia Petroleum Co. by Socony-Vacuum Oil Co. and The Texas Co., amounting to practically 100 percent.

Petroleum in Colombia and Peru. Oil & Gas Journal, December 31, 1936, p. 134. Discusses continued exploration on the Barco concession under the new joint control of The Texas Corp. and the Socony-Vacuum Oil Co., Inc., also the enlarged production from proven fields in Colombia and Peru, by subsidiaries of Imperial Oil Co., Ltd. Maps show the pipe lines, refineries and oil fields of Colombia and Peru.

Colombia. World Petroleum, March, 1931, pp. 217-223. This article describes the oil industry of Colombia, which at the time wsa producing 20,000,000 bbl. of oil per year. The text is illustrated by numerous pictures, maps and tables.

Colombia. Petroleum Times, November 2, 1929. Shows petroleum developments in Colombia, with map showing the various concessions.

Petroleum Production in Colombia. Oildom 1923, vol. 14, No. 12, page 51. Describes plans of the Imperial Oil Co. of Canada and the Tropical Oil Co. to build a 350-mile railroad from the mouth of the Magdalena River.

Oil Possibilities of Colombia, Chester W. Washburne and K. D. White, in Oildom, 1922, vol. 13, No. 8, p. 23. Discussion of current information.

Colombia Oil Developments in 1922. J. H. Sinclair and E. B. Hopkins. Transactions of American Institute of Mining and Engineers. April 1923, No. 1214-P. Gives an outline of activities at that time.

Petroleum in Colombia. Petroleum Times, 1922, vol. 8, p. 979. The Texas Co. enters the field by purchasing acreage.

Finally, those who read Spanish are advised to consult the studies and other material issued by the Colombian Departmento de Minas y Petroleo, Bogota.—Ed.

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INTERNATIONAL REPORTS

THE AUSTRALIAN Minister for the Interior recently stated in the House of Representatives that "While actually no oil in commercial quantities is being obtained, it is considered that the search for oil in Australia has progressed materially as a result of the expenditure incurred by the government." During the year 1937 a total of not less than £78,900 was advanced to companies for geological survey work and test drilling at Roma, Hutton Creek and Arcadia (in Queensland), Kulnura and Mulgoa (New South Wales), and at Lakes Entrance and Longford (Victoria). The government had purchased four drilling rigs for renting to these companies. An expenditure of £4,010 from the special Prospecting for Petroleum Trust Account over this period comprised a contribution of £4,000 by the Commonwealth to the fund provided jointly by the Victorian and Commonwealth governments for scout drilling in Gippsland, Victoria, and the balance represented administrative expenses.

The Commonwealth Oil Advisory Committee has reported the existence in Victoria of a layer eight miles square of oil sands varying from 20 to 40 ft. in thickness and having an oil content of not less that 4,170,000 bbl. The oil is under no natural pressure and commercial production is impracticable except by pumping or some form of repressuring, which will require that the entire area be under one control. The damage done by previous drilling must first be remedied by cementing off water sands at a cost estimated to be from £55,000 to £80,000.

Existing interests are not equipped financially or technically to carry out the necessary operations.

A WILDCAT well at Lobato, in the state of Bahia, Brazil, recently struck what is reported to be a high grade of paraffin-base oil under small pressure at a depth of about 700 ft. A few barrels of the 0.81 gravity crude were recovered and yielded under laboratory distillation, commencing at 60 deg. C., 20 percent of gasoline, 10 percent kerosene, 20 percent gas oil, 25 percent lubricating oil, 20 percent heavy oil and paraffin base grease, and five percent coke and distillation loss. This discovery will be dealt with in detail in the forthcoming annual drilling number of WORLD PETROLEUM.

THE ANNUAL Refinery Issue of WORLD PETROLEUM, 1938, contained on pages 76 to 79 an article by Smoley, Schutte and Davis concerning different processes of solvent refining and dewaxing and listing the different plants erected throughout the

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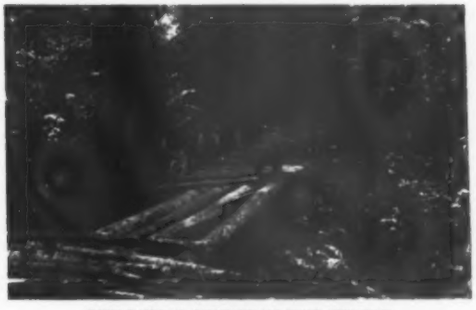

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world. Among others, two Bari-Sol plants and the Standard Franco-Americaine plant were mentioned under the respective headings of the Bari-Sol Process and Other Processes.

Separator-Nobel has called attention to the following points and requests that World Petroleum publish this supplementary information:

These three plants are operated in principle according the same process—the Heavy Solvent Centrifugal Dewaxing Process. The denomination Bari-Sol adopted by Sharples and Max B. Miller for the American plants means "heavy solvent," and to this group of solvents belongs ethylene dichloride as used in those plants as well as trichlorethylene as used in the French plant. The process and centrifuges used were developed about simultaneously, in America by Sharples and Max B. Miller and in Europe by Akt. Separator-Nobel. The process and design are protected by patents, and an agreement was made in 1936 whereby rights and technical information were mutually exchanged between the companies, sale of the process and centrifuges being handled in America by Sharples and Max B. Miller and in Europe by Separator-Nobel.

Thus the Bari-Sol and Heavy Solvent Process are technically and commercially almost identical, especially since Separator-Nobel are also using ethylene dichloride as a basic solvent.

A complete table of heavy solvent centrifugal dewaxing plants erected or on order throughout the world gives a total capacity of 54,450 bbl. per day. The heavy solvent dewaxing plants represent about 13.8 percent of this, and the process ranges as third so far as total capacity is concerned.

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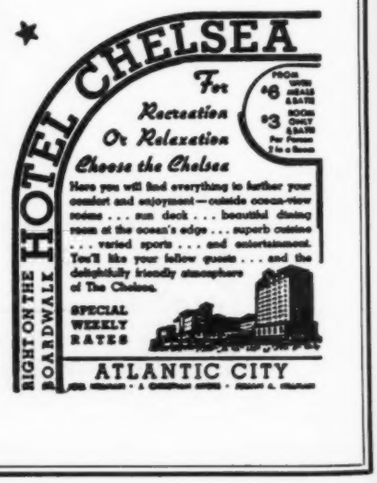
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